The true Effigies of Nathaniell Nye,
Mathematician.

W. Hollar delin: et fecit Aqua forti.
Londini. 1644

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THE ART OF GUNNERY.

Wherein is described the true way to make all sorts of Gunpowder, Guu-match, the Art of shooting in great and small Ordnance: Excellent ways to take Heights, Depths, Distances, accessible, or inaccessible, either single or divers distances at one operation: to draw the Map or Plot of any City, Town, Castle, or other fortified place. To make divers sorts of Artificiall Fire-works, both for War and Recreation, also to cure all such Wounds that are curable, which may chance to happen by Gunpowder or Fire-works.

This Treatise is composed for the help of all such *Gunners and others, that have charge of Artillery*, and are not well versed in *Arithmetick* and *Geometry*: all the rules and directions in this Book, being framed both with and without the help of *Arithmetick*,

By *Nathanael. Nye* Mathematician, Master Gunner of the City of WORCESTER.

LONDON,
Printed for *William Leak*, at the signe of the Crown in *Fleetstreet*, between the two Temple Gates. 1648.

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Lordſhips nature, to cheriſh ingenuous endevours with the particular ſervice I ever did owe and beare to your Lordſhip and Noble Family, occaſioned theſe bold addreſſes

Of your Lordſhips

my LORD,

moſt humble Servant,

N. NYE.

To the Reader.

LOving friend, the cauſe that moved me to ſet Pen to paper to write ſuch a Treatiſe as this Book of Gunnery, was becauſe that in all the Books of this Art yet Printed, I never ſaw one that gave ample directions to attein to any knowledge without the Art of Arithmetick; I do alſo verily believe that when a man hath learned that Art in whole Numbers and Fractions, as alſo to extract

tract the Square and Cube Roots; that he wil be without any of their directions, able to doe that which divers of them imploy half their Books to teach, in this my Treatiſe I have added divers Tables for thy help, to reſolve thoſe things which are elſwhere taught to be reſolved by Arithmetick: *and if thou haſt knowledge in that excellent Art, here are things worth thy obſervation; I am ſure divers of them were never publiſhed before: And whatſoever thou findeſt in my* Fire-works, *I do proteſt to thee, that I have made, and ſtill do make practice of them my ſelf;*

ha-

To the Right Honourable the EARLE of LINDSEY, Lord great CHAMBERLAIN of ENGLAND.

Right Honourable,

THE patronage of Arts being hereditary to your noble Anceſtors, eſpecially that of War, wherein ſo

many of the famous BERTU's have been tranſcendently glorious encouraged theſe few ſheets of mine to crave the protection of your Lordſhips favour againſt the malicious ignorance of this unhappy age. The addreſſes, I do humbly acknowledge ſavour of too much boldneſſe: the Treatiſe ſhort: and the Authour not of yeares Confident to preſent pieces worthy of your Lordſhips favour, or peruſall. Yet the matter in it ſelfe being Noble and ſuitable to theſe times, and the well known propenſity in your

Lord-

having by experience found them the beſt of all others that ever I have read of: or that are taught by Bate, Babington, Norton, Tartaglia, *or* Malthus; *if any man ſhall make the leaſt doubt of what I have ſaid, I am ready to reſolve him: And to conclude, according as thou findeſt the truth of what I have written, ſo give thy doom, I reſt*

Thy loving Friend,

Nathanael Nye.

Arts Mathematicall (in *Worceſter*) Profeſſed by *Nath. Nye* Mathematician, theſe Arts, Sciences, and Faculties here under expreſſed.

- **Arithmetick**
  - In whole Numbers and Fractions,
  - Extraction of Roots
    - Square,
    - Cube,
    - Of Aſtronomicall Fractions.
- **Geometry**
  - The Principles, with the Practice and Demonſtration.
  - Meaſuring of Land and reducing of Plots or Maps, to any Proportion
  - Meaſuring of any ſuperficiall or ſolid content, as Board, Glaſſe, Timber & Stone,
  - Gaging of Veſſels the exacteſt way.
- **Deſcription, Demonſtration, and uſe of Inſtruments.**
  - Quadrant, Theodelite, Plain Table,
  - Circumferenter, Circular Scale,
  - Mathematicall Scale or Sector,
  - Rules by Maſter *Gunter*, converted into a Croſſe-ſtaff.
- **Aſtronomy**
  - The uſe and demonſtration of the Sphear or Globe, both Cæleſtiall and Terreſtriall,
  - The Cæleſtiall Globe in Plain.
  - Navigation
    - The Principles thereof, with the making of divers Inſtruments befitting that Art.
    - The uſe and Projection of Maps and Charts.
    - To finde the true longitude at Sea.
  - To calculate the true motion of the heavens, and to find the eclipſes for any time, either paſt, preſent, or to come.
  - To make Dials of all ſorts, either fixed, or inſtrumentall.

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The Art of Gunnery: AND First of Gunpowder.

CHAP. 1.

Who were the first Inventors of Gunpowder, and how it came to be invented.

Some *Italians* have declared, That *Archimedes* the Philosopher was the first Inventor of Guns and Gunpowder; for *Valturus* declareth in the tenth book of Warfare, That *Archimedes* used a certain kinde of Engine made of Iron, out of which he shot against an Army upon the land (with an incredible noise) stones of great weight and bigness; which Relation makes us believe, That it was an Engine like unto a Gun: But whether this be true, or not, is doubted, for learned men are of

divers mindes: *Munſter* and *Gilbert Cognot* have written, That Guns were deviſed firſt in the year of our Lord 1370 by a Monk, whom *Munſter* calleth *Bertholdus Sthwarts:* Mr. *Dee* our Countrey-man in his Mathematical Preface and Diſcourſe of Menadre, ſaith, That an Engliſh-man was the firſt Inventor of Gunpowder, though his ſaid invention in another land, and by other men, was firſt executed: Alſo our Engliſh *Chronicles* do report, That in the year 1380, a Monk did unwillingly let fall a ſpark of fire upon Brimſtone and Saltpeter, beaten to powder, in a Morter, covered with a flat ſtone; he ſeeing this mixture blow off the ſtone from the Morter, did thereupon deviſe a kinde of Powder, and taught the *Venetians* to uſe the ſame in Iron pipes againſt the *Genuates*.

CHAP.

Chap. 2.

What ſorts of Powder they made (from time to time) from the firſt Invention, to this preſent.

POwder was always made of Saltpeter, Brimſtone and Charcole; although ſome Authors have counſelled to adde to the ſaid materials, Quickſilver, to make it more ſtrong: others advife us to uſe Aquavitæ; ſome would have us adde thereto ſome Armoniack; ſome bid us put thereunto Camphir; ſome make Gunpowder with the coals of Bulruſhes, and divers other ways, which I will not ſet down: But I will here ſhew you the making of Gunpowder from time to time, as it was collected from ſuch Authors as lived either one or two hundred years ſince; by which you may gather, how that Gunpowder hath ſtill mended, and grown to great perfection ſince the firſt invention.

The making of Gunpowder after the moſt ancient maner, *Anno* 1380.

The firſt way,

Saltpeter	one part.
Brimſtone	one part.
Charcole	one part.

The making of Gunpowder, as Authors teach, about the year 1410.

The ſecond way,

Saltpeter	three parts.
Brimſtone	two parts.
Charcole	two parts.

The making of Gunpowder, as it was made in the year 1480.

The third way,

Saltpeter	eight parts.
Brimſtone	three parts.
Charcole	three parts.

The making of the beſt Powder about the year 1520.

The fourth way,

Saltpeter	four parts.
Charcole	one part.
Brimſtone	one part.

The

The beſt ſort as is made now at this preſent.

The fifth way,

Saltpeter	ſix parts.
Brimſtone	one part.
Charcole	one part.

The Musket Powder is now commonly made of Saltpeter five parts, one part of Brimſtone, and one of Cole; and Canon Powder of Saltpeter four times ſo much as of Brimſtone and as of Cole.

Chap. 3.

The reaſon why Power made of ſix pounds of Saltpeter, one pound of Brimſtone, and one of Charcole, is ſtronger then Powder made of ſeven pounds of Saltpeter, one of Brimſtone, and one of Cole; and alſo ſtronger then Powder made of five pounds of Peter, one of Sulpher or Brimſtone, and one of Cole: Or elſe why ſix of Peter, one of Sulpher, and one of Cole, is the ſtrongeſt Powder that can be made.

IT is certain, that the beſt Powder would be that in which is moſt Saltpeter, if a

ſmaller quantity of Sulpher and Cole, then but once ſo much of either of them, as to be one ſixt part to the quantity of Peter, might ſerve; which compoſition I will call 6--1--1, meaning ſix times ſo much Peter, as one time Sulpher, and one time Cole. But leſſe Sulpher and Cole, as 7--1--1, the Sulpher and Cole are not able to perform and execute the office as they ought to do, that is to ſay, to be on fire quickly, and ſet the Saltpeter on fire, and to maintain the ſame fire, until it be wholly reſolved into fire; therefore no more Sulpher and Cole to ſo much Peter, would be to little purpoſe: Certainly if Gunpowder were only made of Peter, that would be more ſtrong then Powder made of Peter, Cole and Brimſtone; but becauſe the ſaid Peter is not apt to burn in a flame quickly, as Brimſtone will do, nor maintain the flame until all is conſumed, as Cole will do, therefore it is needful to adde Sulpher and Cole thereunto, and onely ſuch a quantity as will juſt ſerve turn: In Powder 5--1--1, by experience is found more Sulpher and Cole then needeth; yet it is good not only to make Powder of 5--1--1, which is

Musket

Musket Powder, but alſo of 4--1--1, which ſerveth beſt for great Ordnance. Now the reaſon why this laſt ſort ſhould ſerve better for Ordnance, then Piſtol Powder of 6--1--1, which is the ſtrongeſt of all, I will ſhew in the next Chapter.

Chap. 4.

The reaſon why Piſtol Powder being the ſtrongeſt, is not ſo good for the Canon as Powder 4—1—1, the weakeſt; no not although you take but ſo much of the Piſtol Powder as you finde by an Engine to be of like ſtrength with another quantity of Canon Powder.

THe reaſon why Canon Powder is beſt for Ordnance, is becauſe it taketh up a greater room in the Cylinder of the Piece, then Piſtol Powder; for in taking up much room, it hath the greater fortification of Mettal about it, to keep it from breaking the Piece: Suppoſe a Saker requireth four pound of great Powder for her loading, and I would know how much Piſtol powder is equal in ſtrength to four pound of Canon

Canon powder, trying by an Engine made of purpose to try powder, I finde three pound to be of like force: you may easily conceive that the three pound hath but three quarters of the Mettal of the Piece, to keep it from breaking, when as four pound hath one quarter more Mettal then the other three had.

To make it more plain, if you look into the second Chapter you shall finde, That the first powder of all, was made of just so much Saltpeter, as of Cole, and of Sulpher, called 1—1—1; if you had such powder, and also one of the old Pieces made in those days, as some of them may yet be seen in many Cities of *England*, you could not load them with any other powder but they would break. You shall hear what I have done; I made such kinde of powder as 1—1—1, and tryed how much of that powder was in strength to one pound of Pistol powder, being 6—1—1, by an Engine I found three pounds and nine ounces, the Piece was Saker bore of Iron, and the thickness of the Mettal about the Chamber, was two inches in thickness; I loaded the Piece with four pound of

weak

weak powder, which filled the Cylinder of the bore nine inches juſt; which nine inches in length, and two in thickneſs about the Chamber, is Two hundred twenty five inches of Mettal about the powder, near Forty ſeven pounds weight, at this adventure the Piece came off ſafe; but being loaden with one pound and a quarter of fine powder almoſt, which filled the bore but two inches and three quarters, and had to its fortification but Sixty eight inches and three quarters, which is in weight fifteen pounds, at the diſcharge of the Gun, it brake in divers pieces: This was done in *Deriton*, upon the 17 of *March*, *Anno Dom.* 1644. as many people can witneſs.

Chap. 5.

How to make Artificial Saltpeter of the Earth.

SAltpeter is a mixture of many ſubſtances gotten with fire and water, out of dry and durty earth, or out of that ground which is found looſe within Vaults, Tombs.

Tombs, or desolate Caves, where rain cannot come in, and also Charnel houses; The best of all is made of beasts dung converted into earth, in Stables, or in Dunghils, of a long time not used; and it is requisite, what dung soever it be, that by long continuance of time it be well resolved into earth, and all the moistness dryed up: When you have occasion to make of this dung, or earth, a great quantity of Saltpeter, it will be necessary for you to provide many Cauldrons, Furnaces, Barrels and Tubs, and wood for fire; these Barrels must be set on end upon a Form, the top being taken out, and near the bottom a hole bored with an Augre; you must cover the inside of those holes with an earthen Porringer, and stop the outside with Taps; then fill up the Barrel with the said earth, within a span of the brim, and remember that the earth about the said vessels should be rammed down, yet that part of the earth that lieth in the midst of the vessel, may lie loose; afterwards pour a Bucket of clean water upon the earth, and after that pour another, not failing so do so till all the earth within the

Tub

Tub be well moiſtened, which ought to continue thus one day and night, the water a full hands breadth above the earth; then pull out the Taps or Spiggots out of the holes in the veſſel, and let the water drop out of that veſſel into another, being ſet under it: When you ſee no more water will drop, empty the undermoſt veſſel again into the uppermoſt, out of which it did drop, and out of the ſame let it drop again, ſo long and ſo much as it can; this water when it hath dropped twice, is called water of Foot, and alſo the waſh of earth, and muſt be ſaved by it ſelf: After this pour other clean water upon the very ſame mould in the Tub, and when the ſaid water hath dropped out of the higher veſſel into the Tub that ſtands under, take all the earth out of the upper veſſel, and fill it with more of the ſaid earth, then pour upon this earth in the veſſel, the water as you made firſt, called water of Foot, and waſh of earth, ſuffering it to drop through the ſame into the undermoſt Tub, ſtanding under the earth Tub, ſo often until it be ſo ſalt as to bite your tongue, and that an egg will ſwim on the top of the water: The

firſt

firſt water being brought to this perfection, pour the ſecond water upon the ſaid earth, or other earth, that it may by often paſſing through be of as biting a taſte as the former, as alſo able to bear up an egg: Now this ſecond water being very ſtrong, muſt be boiled in a Cauldron, and after it hath well boiled, abate the fire under the Cauldron, until you have taken off it all the ſcum, which muſt be ſaved in a Pot; then preſently make a good fire, to cauſe it to boil again with ſpeed, and as the water in the Cauldron diminiſheth, ſcum the ſaid water, and keep the ſaid ſcum: When the ſcum ſhall be thick, hard, and of a French Ruſſet colour, take ſome water out of the Cauldron, and let it drop upon a piece of Iron, for if the water be boiled enough, the drops of water will congeal upon the ſame Iron, but if they do not congeal, it is a ſign it may abide the fire longer; when its boiled, as you may perceive by the aforenamed ſigns, take it from the fire, and preſerve it, becauſe it is the Peter-water: Now when you have made an end of boiling the ſecond water, you muſt boil and ſcum the firſt water (named water of Foot, or waſh

of

of earth) till it ſhall caſt up a ſcum of a French Ruſſet colour, unto which if it ſhould happen to cleave to the ſides of the Cauldron, you may put in the other Ruſſet ſcum (that was made and ſaved by you before) to boil with it, until the drops of this water falling upon Iron will congeal; if this congealed water be very ſoft, you muſt boil it longer, but if hard, it is a ſign it is burned; to amend this fault, put ſome clear water thereunto to amend it, then taking the Cauldron from off the fire, and ſetting it aſtoop, ſo that the lies and drugs (which being congealed are the very ſalt whereof Saltpeter is made) may not with any water run over the brims of the veſſel: You muſt (if you will make good Peter) ſuffer the ſaid water to ſettle in the ſame veſſel, and congeal in a dankiſh room, and the water which after two or three days will not congeal, hath dropped into ſome other Tub, take the Saltpeter out, and preſerve the water that dropped, becauſe it is Maſter water, and ſhall afterwards be uſed as I ſhall give you directions.

CHAP.

Chap. 6.

To make another excellent sort of Saltpeter of Flower that groweth on walls: How Saltpeter water must be boiled, and how you may know when it is boiled enough.

TAke of flower or plaster that groweth on walls four parts, of unslack't lime one part; this one part of lime must be well boiled in water over a fire, and after it hath boiled enough, it must be taken from the fire, and suffered to settle, then it must be strained into another vessel; then put the four parts of flower into such a vessel as I in the last Chapter ordered for earth; pour upon the said flower so much of the strained water, which I call lie or lime water, as will dissolve the flower; when the flower is dissolved, let the water drop out of the said vessel, into an under vessel; then boil those said drops of lime water over the fire, till they being put upon Iron will congeal, and be of a temperate hardnesse; for if they are very hard, the water is burned, but if soft, not enough; when it is well boiled (that is, to have the drops thereof

on

on Iron neither too hard nor too ſoft) take it from the fire, and ſcum it with a ſcummer, and do unto it all that hath been taught in the laſt Chapter to be done with Peter-water.

Chap. 7.

To make a third ſort of Saltpeter very excellent, and with more eaſe, and leſs coſt then the two former ways.

TAke Quicklime, and pour warm water upon it, and let it ſtand ſix days, ſtirring it once or twice a day; take the clear of this water, ſet it in the Sun until it be waſted, and the Saltpeter will remain in the bottom.

Chap. 8.

How to refine Saltpeter, to make it fit for uſe.

PUt Saltpeter with well ſlacked lime into a clean Cauldron, and pour upon it ſo much lime water, or fair water, as will lie

lie four fingers in height above the Peter and lime, and make a good fire under the Cauldron, that they may quickly boil, and be you ready, as ſcum ſhall riſe, to take it away with a ſcummer; when you perceive that no more ſcum will riſe, take the Kettle from the fire, and ſetting it ſomewhat aſlope, let the boiled water cool, ſettle and clear in the Sun; if the boiled water will not wax clean by this means, put aſhes into it, and boil the ſame again a little while: This done, take the Cauldron again from the fire, and ſet it aſlope, ſprinkle on the boiled water ſome fair water cold, for by ſo doing you ſhall make the ſaid water clear; this water being clear, muſt by little and little be poured out into ſome other veſſel, ſo that the dregs or grounds may not go out with the ſame; for the water which lieth above in the veſſel Saltpeter is made, and in the water below at the bottom of the veſſel, which are the lies or dregs of Saltpeter; after you have in this ſort poured out the ſaid water into other veſſels, and have ſuffered the ſame for two days (or more if need be) to congeal in the ſame veſſels, you muſt take the

the ſaid congealed water (which is Saltpeter) out of the veſſels, and dry the ſame with the heat of the Sun, or by the fire.

After you have taken the ſaid Saltpeter out of the veſſels, the water which remains boil over a good fire, and when it caſts up any ſcum, take the ſcum off, then try whether it be enough, by dropping ſome on Iron, if it congeal in a temperate way, take it from the fire; this being done, as it cooleth you ſhall ſee a thin skin to lie upon the water, which alſo ſcum off; this water will then congeal into Peter, as did the other, but it is not ſo good.

To refine Saltpeter with fire, do thus, Take an Iron Skellet and fill it with Peter, ſet it on the fire, and cover it cloſe with ſome Iron cover on the top, or with a Tyle; when the Saltpeter is melted, take Brimſtone moſt finely beaten, and caſt ſome thereon, kindle it, and let it burn till all the upper part be burned; which when effected, will leave the Saltpeter clear like to a piece of Marble, for the Brimſtone will burn up the groſs victiouſneſs of the Saltpeter.

Chap. 9.

How Saltpeter meal is made, and how Peter meal without any beating, will serve to make Gunpowder with his materials.

HAng a Kettle over the fire, and put Saltpeter therein; when it shall begin to boil, fry and smoke, stir it about with a wooden Ladle, cease not to mingle the Saltpeter well together, until it wax dry, for by so doing you shall take away the greese and salt that was in it; then pouring so much water into the Kettle as will cover the Peter, you must melt the Peter again over the fire, continually stirring it, until it become dry as before, and be like meal.

Chap. 10.

How the makers of Gunpowder do mingle together the materials of which they do make Gunpowder: And also how to corn the Powder.

PUt all the Saltpeter together that you will use into a Cauldron, for if it be to

make

make Canon powder, you must take four parts of Peter, one part Brimstone, and one part Cole; if Musket powder 5—1—1; if Pistol powder 6—1—1: boil the Salt-peter in a Cauldron, with so much water as will serve to dissolve it; which being so dissolved, ought to be washed and laid upon a clean place; this done, beat into dust the quantity of Cole that is to be added to this mixture, and then put this dust or fine beaten Cole unto the dissolved Peter, incorporate them very well together, and as you are blending them, put in by little and little the Sulpher very well beaten; when this mixture of Saltpeter, Brimstone and Cole are well incorporated, lay it forth to dry a little; when the same mixture is somewhat dryed, by beating the Cole until it is subtile and inpalpible, and is made a very well mixed substance, sift it well through a sive; then casting water or vineger upon it, corn it; and when you have so done, dry it against the fire, and Gunpowder is made. There are divers ways to grinde Gunpowder, the best way is to stamp it in Morters, with a Horse-mill or Water-mill, for the powder is thereby

moſt finely beaten, and with leaſt labor; with a knife cut in pieces ſome of this compoſition, and if it appear all black, it is well done, but if any of the Brimſtone or Peter is ſeen, it is not incorporated enough: Now I will ſhew you how to corn Gunpowder.

Firſt, prepare a five, with a bottom of thick parchment, made full of round holes, then moiſten the powder, which ſhall be corned, with water, put the ſame and alſo a little bowl into the five, when you have ſo done, ſift the powder, ſo as the bowl rowling up and down in the five, may break the clods of powder, and make it by running through the little holes, to corn.

You may alſo make Gunpowder by ſifting every one of the three materials by it ſelf through a very fine five, and then moiſten them with ſtrong vineger, and incorporate them together, for through that moiſtneſs the powder will be made more ſtronger, and beaten more finer, then corn it as before is taught: Note, That if you cannot ſift it through the five, beat that again into powder which will not through, until

until it will go through alſo; when you have ſifted theſe materials two or three times ſeverally, then blend them well together, and ſift them alſo together; when you have done this, then moiſten them with vineger, and proceed as before: Remember alſo, That Charcole made of the lighteſt wood is beſt.

Chap. II.

To make Powder of divers colours; and firſt to make White Powder.

TAke of Saltpeter twelve parts, of Brimſtone two parts, and of Camphir one part, beat, ſift and incorporate all theſe things together, as before you have been taught to mix other materials together; after you have ſo done, beat theſe things ſo again, and ſo oft, until you are ſure they are well incorporated, then moſten it with Aquavitæ; when you have thus done, corn the powder.

To make Red Powder.

Take of Saltpeter twelve parts, of Brimſtone two parts, and of Camphir one part, beat, ſift and incorporate all theſe things together, as I taught juſt now; then beat them again, until they are perfectly incorporated: whereas before you moiſtned them with good Aquavitæ, now you muſt moiſten this with Vineger (ſod with a good quantity of Braſil, until the third part be boiled away) this Vineger being red as blood, will make the powder likewiſe ſo, it being moiſtned with it, and then corned as before is taught.

To make any other coloured Powder.

Boil the Vineger in ſuch tranſparent colours as you would have the powder to be of; as if green, with a little Verdigreace, if blue, with blue Bice, and the like; always taking care, That the colour be not thick, but very thin, otherwiſe it will weaken the powder that you do make.

CHAP.

Chap. 12.

To renew and make good again any ſort of Gunpowder that hath loſt its ſtrength by moiſture, long lying, or by any other means.

HAving moiſtened the ſaid Gunpowder with Vineger, or fair water, beat it well in a Morter, and then ſift it through a five or fine ſearſe; with every pound of Gunpowder, mingle one ounce of Saltpeter that hath been mealed; and when you have ſo done, beat and moiſten this mixture again, until you ſee by breaking or cutting with a knife, that there is no ſign of Saltpeter or Brimſtone in it: Moreover, corn this powder when it is incorporated with the Peter as it ought to be, and you have done.

Chap. 13.

Another way to renew Gunpowder, or rather to unmake Gunpowder, to make it good, in the making it again.

PUt ſo much thereof (as you will refine or new make again) into a linen bag, and then tie a ſtring or rather ſmall cord about the mouth of the ſaid bag, then put it into a clean Kettle, and pour ſo much water therein as will cover the bag; this done, make the water to boil, till a drop of it laid upon iron or ſtone will congeal; and while the water boileth, remember to ſcum it, if need require; when it will congeal, take it from the fire, and ſet the Kettle aſlope; when the water is as clear as it will be, pour it out into ſome veſſel where it will congeal into Saltpeter; when you have taken the Saltpeter out of the ſaid veſſel, that water as remains, boil again, until it will (by dropping a drop thereof upon iron) congeal, then put it again into the ſame veſſel: and thus do with all ſuch water as is laſt, after you have taken out the Peter.

The

The Saltpeter and Brimſtone which were within the ſaid bag, did diſſolve and ſoke into the boiling water; yea, the diſſolved Peter turned into water, and the Brimſtone ſunk down to the bottom of the water, where you may finde it; but the Coles (which were formerly compounded with the Peter and Brimſtone) they remain in the bag, amongſt the lies and dregs of the decayed Gunpowder: therefore when you have gathered together all the Saltpeter by the means above named, and dryed the ſame, weigh it, and alſo weigh the Brimſtone and Cole by themſelves, and what you finde every thing to want in its quality and due proportion, make up with more, then mingle, beat and incorporate them, as you have been taught to make new Gunpowder.

CHAP.

Chap. 14.

How you may by taſte, feeling, colour and burning, know good and ill Powder; and how amongſt many ſorts of Gunpowder you may know the beſt ſort.

1. BY how much Gunpowder is the harder in feeling, by ſo much the better it is.

2. Gunpowder of a fair Azure or French Ruſſet colour, is very good, and it may be judged to have all its receipts well wrought, and ſufficient of the Peter well refined.

3. Lay two or three corns of Gunpowder upon a white piece of paper, the one three fingers diſtant from the other, and put fire to one of them, if the powder be good and ſtrong, you ſhall ſee them all on fire at once, and that there will remain no groſsneſs of Brimſtone or of Saltpeter, no not any thing but a white ſmoky colour in the place where they were burned, neither will the paper be touched.

4. If good Gunpowder be laid upon the palm of your hand, and ſet on fire,

fire, you will not be buined.

5. Gunpowder that hath a very ſharp taſte, hath abundance of the Peter not well refined, and will moiſten again.

6. If white knots, or knots of a french ruſſet colour, ſhall remain after powder is fired, it is a ſign that the Saltpeter was not well refined, but left full of ſalt, and greaſe; eſpecially when the ſame knots ſhall in burning be dankiſh, and leave moiſture in the place where the Gunpowder was burned.

7. If hard, dry and white knots, or pearls, ſhall remain after the Gunpowder is ſet on fire, it is a ſign that the Gunpowder is not well wrought, and it becometh every Gunner to beware of ſuch powder, becauſe if it doth lie long in a Piece, it will wax ſo fine, that if you unload not the Piece, it will in his diſcharge indanger the Piece of Breaking.

8. If ſmall black knots (which will burn downwards in the place where proof is made) remain after firing, they do ſhew that the Gunpowder hath not enough of the Peter, and that it is of little force or ſtrength, and ſlow in firing.

9. If a little heap of Gunpowder ſet a fire, doth make a noiſe, riſe up with great ſpeed, and yield little ſmoke, it is a ſign of very good powder.

10. If the flame of fired Gunpowder ſhall riſe up ſlowly, continue long, make little noiſe, and yield ſmoke in great abundance, it is a ſign the powder hath much Cole and Brimſtone, and too little Peter.

11. If Gunpowder burned upon a board ſhall black the ſame, it is a ſign that there is overmuch Cole in that powder.

12. When Gunpowder is moiſt, or full of the earth of Saltpeter, it is naught to be ſhot out of great Ordnance, for it ſhameth the Gunner which uſeth it.

13. If Gunpowder be very black, it is either a ſign that there is too much Cole, or that it is moiſt, and when you rub it upon white paper, it will black it more then other good Gunpowder will do.

14. Amongſt many ſorts of powder to know the beſt, make a little heap of every ſort, and then ſetting thoſe heaps one from another, mark well when you put fire unto them, which of the heaps did ſooneſt take fire; for that powder which will ſooneſt be

on fire, ſmoke leaſt, and leave leaſt ſigh behinde it, is the beſt ſort of Gunpowder.

Chap. 15.

How to make excellent good match to give fire to any Ordnance, &c.

TAke cords made of hemp thats not very fine, or of toe, which is better, although it will ſooner conſume, and let every cord be ſo big as a mans little finger; this done, boil the ſaid cords in ſtrong lie, aſhes, and a little Saltpeter till all the lie be waſted.

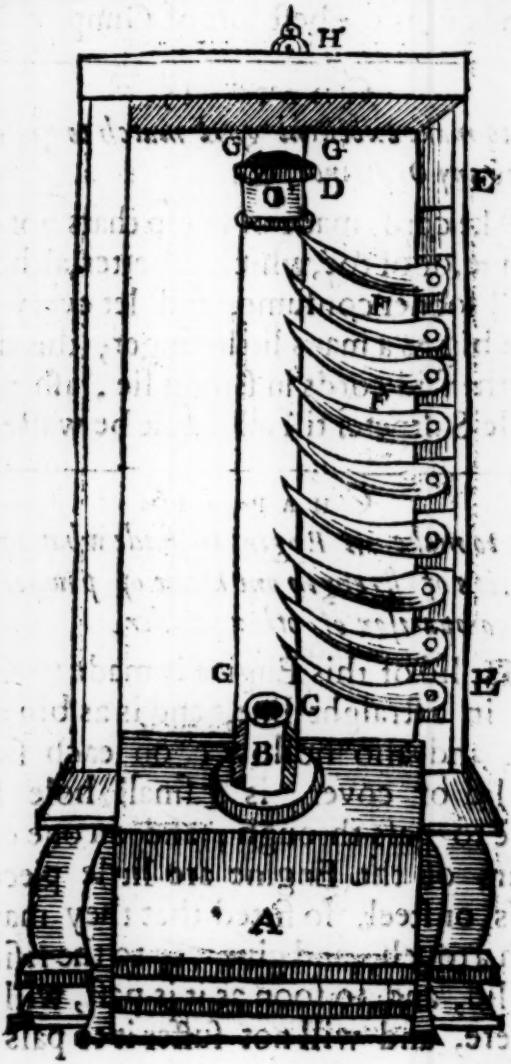
Chap. 16.

How to make an Engine to finde what proportion of ſtrength one kinde of powder is in compariſon of other powder.

THe lid of this Engine is made to riſe up in a ſtraight line, and is as big as the box, and alſo hollow; on each ſide of the lid or cover, is a ſmall hole for a wyre to paſs through, and on one of the pillars of the Engine are little pieces of braſs, or ſteel, ſo fitted that they may riſe with a touch, and give way to the riſing of the lid, and ſo ſoon as it is paſt, will hold it there, and will not ſuffer it to paſs back

again

again; the form whereof is here presented.



A The

A The foot whereon the Engine ſtandeth.

B The powder box, which hath two ſmall wyres paſſing from each ſide to the top, to keep ſteddy the lid in its motion.

D The lid, which hath alſo two holes on each ſide for the wyres to paſs through.

E the ſide of the Engine, which is divided, on which is placed at every diviſion, one of thoſe Pieces to ſlide up and catch the lid.

FF The form of thoſe catches, being either of ſteel or braſs.

GG The two wyres that guide the box lid, and muſt be put into a little piece of braſs, at the top, which may be ſcrewed higher or lower at pleaſure, for the better ſtraightning of the ſame.

H The ſcrew which ſtraightneth thoſe wyres, placed on the top.

The uſe of this Engine.

Take about one dram of ſuch a ſort of powder as you eſteem to be the beſt of all others, and put it into the box, after it is covered with the lid, at the touch hole, which is in the bottom of the box, fire it with a red

red hot wyre, being firſt primed with powder duſt; then obſerve how high and to what diviſion it aſcends, which being noted down, take juſt ſo much powder of a courſer ſort, and try that in like maner as you did the former; then by noting up to what degree it aſcendeth to, you may perceive the juſt difference between your beſt and worſt powder; and by the ſame order of any other ſort, as you ſhall deſire to know its ſtrength, and have occaſion to uſe.

But in the next Chapter, I ſhall deſcribe ſome other ways, becauſe every man cannot come by a good inſtrument to try the juſt ſtrength of any powder.

CHAP. 17.

How to try the ſtrength of Powder ſome other ways then is before rehearſed.

IF you charge a Piſtol, and diſcharge it againſt a bank of clay; do this with a little powder, always obſerving to take the like quantity to a grain of one ſort of powder, as you do another ſort: Then by meaſuring

meaſuring how far the bullet pierced in the clay, you may have ſome geſs at the ſtrength: alſo if you can make Rockets, ſuch as fly into the air, and are made of Powder-duſt, and Charcole-duſt, by the ſtrength or weakneſs of theſe you may know the like of powder.

If you can get a little Morter Piece (what a Morter Piece is you may read anon) caſt at the iron furnace where caſt the iron is made, to get one made in ſuch a place is no difficult thing: Let it be made about three inches Diam: at the mouth, and let the Chamber of the ſaid Piece be three quarters of an inch Diam: and two inches and one third part of an inch deep, load the Chamber with about half an ounce of powder, but put no wad in after it, the reaſon is, becauſe one wad may be bigger then another, which will cauſe error; then put into your Morter a Bullet of Lead or Iron that will juſt fit the bore: now if it be of Iron, it will weigh three pound and ten ounces, if of Lead, almoſt five pound: This Morter-piece being erected at a certain and unvariable elevation, and then being diſcharged, ſhall (by its ſeveral ranges)

tell the exact difference of powder above any other inſtrument that can be invented, for by noting how many paces a ſhot rangeth, you ſhall finde the true difference, and be able to ſet down the true and infallible proportion betwixt all ſorts of powder whatſoever.

Becauſe you may fail in procuriug one made at the Furnace where Iron is made, I will ſhew you in the following Treatiſe, how you may make ſuch a one which may ſerve your turn.

Thus having in the foregoing Treatiſe ſet down by whom, at what time, of what ſtrength and violence Gunpowder was at when invented; alſo how to make any ſort of Gunpowder, & laſtly to try its ſtrength: I ſhall hence-following ſet down ſuch Rules, that an ingenious man may learn to be a perfect Gunner, for I have omitted nothing that is neceſſary in that Art.

CHAP.

Chap. 18.

Hence-forward ſhall be taught the Art of Gunnery: And firſt, what hath been the cauſe why this Science is not of the like eſteem as ſuch a noble Art deſerveth, and who are the cauſers and diſeſteemers of it.

THe true reaſon why this ſo famous an Art is at this preſent ſo ſlighted, is becauſe divers men for lucre of gains and good pay, have made friends, or ſome of them are friends and kinſmen to ſuch as have authority to place and diſplace Gunners; and when ſuch men as theſe ſhould do ſervice againſt the Enemy with their Guns, they bewray themſelves what they are, which maketh ſome as ignorant Commanders (as they themſelves are ignorant Gunners) to ſay, I could have made a better ſhot my ſelf; I do not think but I could level a piece with the beſt Gunner in *England*; it is as eaſie to ſhoot in a great Gun as in a Muſket; what need is there of maintaining any to be Gunners, conſidering we may have men at the twinkling of an eye to do as good ſervice, and are as good

Gunners as theſe; ſuch ſpeeches are uſual, when tidings of little or no ſervice comes to the knowledge of ſuch Committees and Governors (they never finde fault with themſelves) that chooſe thoſe Gunners, becauſe divers of them are their friends and kinſmen, but lay all the blame on the Art ſaying, It is unprofitable, it ſpends more powder then do's good ſervice; ſcarce ever conſidering what a good Gunner may do: I appeal to any reaſonable mans judgemen, whether ſo good Muſique can be expected from him who never touched Inſtrument, as from him which hath ſerved and practiced above ſeven years in that profeſſion? if an Inſtrument be naught, the Muſique cannot be very good; likewiſe if a Gun be naught, it cannot work good effects: as in Muſique, if any ſtrings be wanting it is defective; thus in Guns, if materials be wanting, no reaſonable man can expect the like ſervice, as when nothing is wanting, though it be at the hands of a good Gunner.

It is an evident thing, that if the ſhot hit ſuch a mark (where execution may be done) that the effect will be according to every ones

ones desire: It is also as evident, that the Art of Gunnery doth teach how, and with what Piece to hit any mark in its command: And it is also as evident, that such Gunners may be found which are perfect in the whole Art; therefore (I conclude) that it is most of all evident, that the fault is not in this Art, but in such Commanders, Committees and others which the King or Parliament trusts in their Army or Garisons to make choise of Gunners.

Chap. 19.

The Properties, Office and Duty of a Gunner.

A Gunner ought to be skilful in Arithmetick and Geometry, to the end he may be able through his knowledge in those Arts, to measure heights, depths, breadths and length, and to draw the plot of any piece of ground, to make Mines, Countermines, Artificial Fireworks, Rampiars, Baskets of earth, and such like things which are used in the time of War, to be made for offensive or defensive service.

A Gunner that hath a charge, ought to have in readineſs all neceſſary things for his Artillery, theſe are Wheels, Axeltrees, Ladles, Rammers, Sheepskins to make Spunges, Gunpowder, Shot, Tampions, Chain ſhot, Croſs-bar-ſhot, Canvas, or ſtrong paper (to make Cartredges) Fire-works, artificial Torches, dark Lanthorns, a gin to mount and diſmount Guns, Hand-ſpikes, Coyns, Budge-barrels to carry powder, and Baskets to carry ſhot to your Piece; he is always, when leaſure will permit, to chooſe good Matchcords, to arm his Linſtock wherewith he muſt give fire.

A Gunner ſhould never be without a Ruler and Compaſſes to meaſure the Diameter or Bore of every Piece; and alſo the length of the Cylinder within, the better to fit her with a ſhot, and proportion a charge.

A Gunner ought to know the names, length, weight and fortification of every Piece about the Chamber (that is, ſo far as the Piece is loaden with powder) and be able to tell readily how much Gunpowder is a due charge for every Piece, what ſhot is fit, how many Matroſſes muſt attend the

ſame

ſame upon ſervice, how many Horſes or Oxen will draw the ſaid Piece, and in caſe they cannot be had, how many men will ſerve: And laſtly, he ſhould know how to charge and diſcharge Gunner like.

A Gunner ought not at any time to beat up the head of his powder barrels with an iron tool, but with a wooden mallet, which can never fire the ſame.

Every Gunner before he beginneth to ſhoot, ought to conſider, that a long wad of Hay, or of untwiſted Ropes, will make the ſhot to ſhoot wide of the mark.

Every Gunner before he beginneth to ſhoot, ought to conſider, whether the Trunnions be truly placed in the Carriage, whether the Carriage have a true length, whether one wheel be higher or reverſe faſter then the other, whether the platform whereon the Piece is to do ſervice, be level, or not; if not, to get the ſame amended: Laſtly, to make clean the platform, that no ſtone or other thing lie for the wheels to run upon, for all theſe things not well obſerved, will cauſe the Piece to erre.

Every Gunner before he loadeth his

Piece, muſt try whether it be true bored or not; if not, he is to proportion his charge according to the thinneſt ſide of the mettal; he muſt take his obſervation at the brich of the Piece, juſt over where he ſhall finde (by his art) where the middle of the bore within the Piece is; by this means he ſhall make a good ſhot, out of a bad Piece.

Every Gunner before he makes his ſhot, ought to conſider that if the Piece lye point-blanck, or under mettal, he ought to put in a ſufficient wad after the ſhot, to keep it cloſe to the powder; for if it ſhould not be cloſe, but ſome diſtance between, the Piece would break in the vacant place: but if in caſe you mount your Piece, then put no wad after the ſhot.

And one chief thing in the laſt place, to know very well how to diſpart his Piece, be it either true bored, or not true bored, which he may try firſt.

CHAP.

Chap. 20.

What qualifications every man ought to have, when he firſt gets or obtains (from ſuch as are in Authority) Commiſſion to be a Gunner.

He ought to have skill in the Arithmetick, to Adde, Subtract, Multiply, Divide, to work any concluſion by the ſingle or double Rule of Three; to abſtract both the Square and Cube Roots, and to be perfect in the Art of Decimal Arithmetick: To touch theſe things I need not, being learnedly treated of by Mr. *Record*, Mr. *Johnſon*, and beſt of all by *Jurdans* Arithmetick; all which Books are eaſie to be had, and at a cheap price: Whoſoever hath not theſe qualifications, and no deſire to learn them, he ſhall never be good Gunner; therefore I boldly affirm, That no honeſt man takes upon him this profeſſion (but ſuch as are thus learned) for it is not the duty of an honeſt man, to undertake that (for the King or Parliament ſervice) as he is not able to perform.

When a fit man is entertained, the Maſter Gunner

Gunner whom he ſerves ſhould bring him to his Piece, and give him the denomination of every particular part, and other neceſſary things belonging to his Piece; which when he hath perfectly learned (which is the Baſe-Ring, the Trunnion-Ring, or Rings, the Trunnions, the Muſſel-Ring, the Handſpikes, the Coyns; and alſo deſcribed how far in the Bore is called the Chamber of his Piece) he may, theſe things underſtood, proceed as followeth.

Chap. 21.

How to make the true Diſpart of any (true bored) Piece of Ordnance.

GIrt the Piece round about the Baſe-Ring at the britch with a thrid, and alſo the Muſſel-Ring at the mouth; lay theſe two ſtrings upon a Table at length, and make two marks for the length of each ſtring; divide the diſtance between each of theſe two marks into Twenty two equal parts, with your compaſſes, and ſeven of them is the juſt Diameter; then meaſure with your compaſſes how many inches, and

and parts of an inch, each of theſe Diameters are; ſubtract the greater Diameter out of the leſſer, and take the juſt half of the difference, and that is the true Diſpart, in inches and parts of an inch.

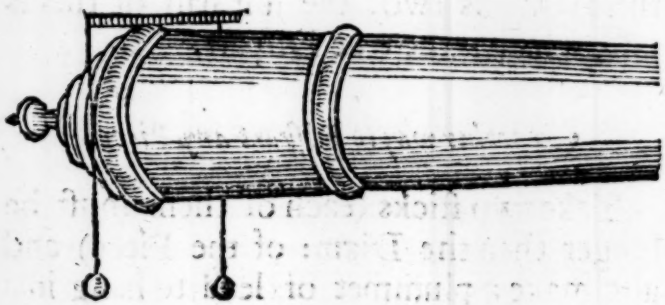
Example.

Suppoſe when I have meaſured the length of each ſtring, and divided it into Twenty two equal parts, I finde that ſeven parts of the longer ſtring are ten inches, and ſeven parts of the ſhorter are Eight inches; I ſubtract eight out of ten, and there remains two, the juſt half of this is one, which is the true Diſpart.

Another way to Diſpart any Piece.

Take two ſticks (each of them muſt be longer then the Diam: of the Piece) and alſo make a plummet of lead to hang in a ſmall thrid, put one of the ends of the ſtick, which you ſhall lay acroſs the top of the Baſe-ring, to and fro, until the plummet deſcending from the end thereof, may juſt touch the ſide of the mettal of the ſaid Ring;

Ring; then keeping faſt the ſtick in that place, hang your plummet by the other ſide of the ſtick, until it juſt touch the mettal of the Baſe-Ring on that ſide; when you have thus done, cut off the ſtick juſt at that place from whence the plummet deſcended perpendicularly; and this length is the juſt Diameter of the Baſe-Ring, upon this maner you muſt make the length of the Diameter of the Muſſel-Ring: Finally, put theſe ſticks together, and finde the difference, the juſt half thereof is the true Diſpart: But I could adviſe the inge-



nious Practitioner to try both ways, and in caſe he findes any difference, to try and try again, otherwiſe he may be deceived: For the better underſtanding of this concluſion,

cluſion, I have here prefixed the demonſtration.

A third way to Diſpart a Piece of Ordnance.

If the Piece be not Chamber-bored, take the priming iron, and put it down in the touch-hole, until it ſtop at the mettal in the bottom of the bore, there make a mark level with the Baſe-Ring, apply the priming iron to the bottom of the mettal at the mouth, and ſo much higher as the mark is (which you made at the Baſe-Ring) then the Muſſel-Ring, ſo much is the true Diſpart.

Chap. 22.

An obſervation to know whether your Piece be Chamber-bored.

Firſt, Diſpart the Piece the two firſt ways, and when thoſe two ways agree in one, take that for the true Diſpart; then with your priming iron take the Diſpart this laſt way; which done, compare it with the other Diſpart firſt found, and what

what it wants is the juſt difference of the Chamber from the Bore of the Piece: Suppoſe the Diſpart truly found by the two firſt ways be three inches, and by this laſt way to be but two inches, it ſhews that the Chamber differs from the true Bore on each ſide one inch; ſo that if the Bore of the Piece be ſix inches high, the Chamber being one inch on each ſide lower, is but four inches high: This obſervation I would always have you to make, that you be not afterwards deceived, in making Cartredges of Paper to load the ſame withal.

Chap. 23.

To know what Diameter every ſhot muſt be of, to fit any Piece of Ordnance; or to chooſe ſhot for Ordnance.

DIvide the Bore of the Piece into Twenty equal parts, and one of theſe parts is ſufficient vent for any Piece; the reſt of the nineteen parts muſt be the height of the ſhot: But moſt Gunners now adays allow the ſhot to be juſt one quarter of an inch

inch lower then the Bore of the Piece; which rule makes the ſhot too big for a Canon, and too little for a Faulcon; but if the mouth of the Piece be grown wider then the reſt of the cylinder within, by often ſhooting; to chooſe a ſhot for ſuch a Piece, you muſt try with ſeveral Rammer heads, until you finde the Diameter of the Bore in that place where the ſhot uſeth to lie in the Piece; and a ſhot of one Twentieth part lower then that place, is ſufficient.

Every Gunner ought to try his Piece, whether it be not wider in the mouth then the reſt of the Chaſe, and then proceed to chooſe his ſhot.

Chap. 24.

To finde what flaws, cracks and honycombs are in Pieces of Ordnance.

SO ſoon as you have diſcharged a Piece of Ordnance, cover the mouth of the Piece cloſe, and ſtop the touch-hole at that

that inſtant; by this you may know if any unknown cracks or flaws do go through the mettal, for if they do, a viſible ſmoke will come through thoſe cracks and flaws.

Alſo it is a good way, when the Sun ſhineth, to take a ſteel (or other) Looking-glaſs, and with the ſame, reflect the beams of the Sun into the mouth or hollow Cylinder of the Piece; for by this means a bright and clear light will be within, and by that ſplendious light you ſhall ſee every flaw, crack or honycomb.

But in caſe the Sun doth not ſhine, take a ſtick, ſomwhat longer then the piece, having cloven one end of the ſaid ſtick for to hold an end of candle, put the ſaid ſtick, with the candle lighted, into the Piece; by this light obſerve, ſo well as you can, whether from the one end to the other, there be any of the aforeſaid in the Piece.

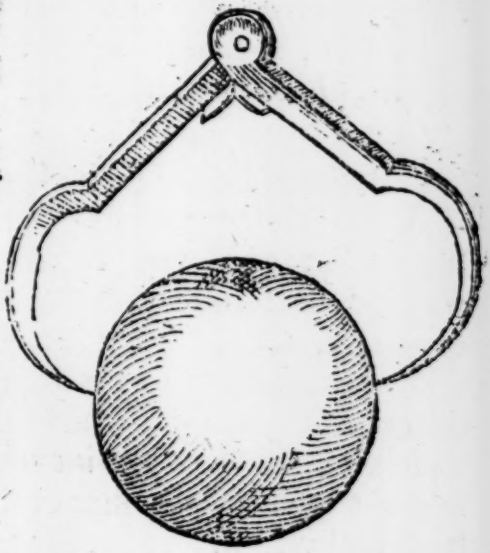
Alſo, if (in ſtriking a Piece of Artillery upon the outſide of the mettal with an iron hammer) you ſhall at any ſtroke hear a hoarſe ſound, then without doubt there are honycombs, &c. but if you ſo ſtriking the Piece ſhall at every ſtroke hear a clear ſound,

found, assuredly the Piece is clear of any dangerous flaws cracks or honycombs.

Chap. 25.

How to finde the Diameter of any round shot, by the circumference.

YOu must gird the shot with a line, then divide that line into twenty two equal parts, and Seven of those parts is the Diameter or height of the shot.



But the best way to avoid al mistakes is to take the said height or Diam: of the shot with a pair of Callaper compasses, as you may see by this demonstration.

Alſo by ſuch a pair of Callapers you may finde the Diam: of the Baſe-Ring, and of the Muſſel-Ring, of any Piece of Ordnance; and by taking half the difference of thoſe two Diameters you may make the diſpart.

Chap. 26.

How by knowing the height and weight of one bullet, to finde the weight of another bullet, the height being given.

A Bullet of iron of ſix inches hie, weigheth thirty pounds; what will the like bullet of ſeven inches in height weigh? Reſolution, firſt, Multiply ſix cubically, then multiply ſeven cubically; then as the cube of ſix, is in proportion to the cube of ſeven; ſo thirty pounds (the weight of a ſhot of ſix inches high) is to ſo many pounds as a ſhot of ſeven inches high will weigh.

Example.

Example.

First, I multiply ſix cubically, there ariſeth two hundred and ſixteen, then I multiply ſeven cubically, which is three hundred forty nine; then I ſay, as two hundred and ſixteen is to three hundred forty three, ſo thirty (the weight of ſix inches high) is to forty ſeven pounds, ten ounces, and one quarter; the weight of a ſhot ſeven inches high.

How to help thoſe that cannot abſtract the cube root (to reſolve this proportion) two ſeveral ways.

The firſt way is, to learn the uſe of a Table of cube roots, which I have annexed for the uſe and help of ſuch as cannot extract the cube root, becauſe my book ſhould be as profitable an help as any Book ever hath yet been; for by this Table, you may learn to work almoſt any concluſion, as well as if you could extract the Root, and with more eaſe.

An excellent Table to finde the Cube root of any number not exceeding 1000000.

The root.	The cube.	The root.	The cube.	The root.	The cube.
1 1/4	1 95	7 1/2	421 87	18	5832
1 1/2	3 37	7 3/4	465 48	18 1/2	6332
1 3/4	5 36	8	512	19	6859
2	8	8 1/4	561 51	19 1/2	7415
2 1/4	11 39	8 1/2	614 12	20	8000
2 1/2	15 62	8 3/4	669 92	20 1/2	8615
2 3/4	20 80	9	727	21	9261
3	27	9 1/4	791 45	21 1/2	9938
3 1/4	34 33	9 1/2	857 37	22	10648
3 1/2	42 32	9 3/4	926 39	22 1/2	11390
3 3/4	52 73	10	1000	23	12167
4	64	10 1/2	115 76	23 1/2	127,8.
4 1/4	76 77	11	1331	24	13024
4 1/2	91 12	11 1/2	1520 87	24 1/2	14705
4 3/4	107 17	12	1728	25	15625
5	125	12 1/2	1953 12	25 1/2	16581
5 1/4	144 90	13	2197	26	17576
5 1/2	167 37	13 1/2	2460 37	26 1/2	18609
5 3/4	190 11	14	2744	27	19683
6	210	14 1/2	30275 25	27 1/2	20797
6 1/4	244 14	15	3375	28	21972
6 1/2	274 62	15 1/2	3724	28 1/2	23149
6 3/4	307 55	16	4096	29	24389
7	343	16 1/2	4492	29 1/2	25672
7 1/4	381 08	17	4913	30	27000
		17 1/2	5359	30 1/2	28372

	the cube		the cube		the cube.
31	29792	58	195112	84	592604
32	32768	59	205379	85	614125
33	35937	60	216000	86	646056
34	39304	61	216981	87	648303
35	42125	62	238328	88	681472
36	48656	63	250047	89	701669
37	50653	64	262344	90	729000
38	54872	65	274635	91	753571
39	55419	66	287496	92	778688
40	64000	67	300753	93	804357
41	68921	68	314432	94	830584
42	74088	69	329199	95	857375
43	79507	70	333000	96	884736
44	85184	71	357911	97	615673
45	91125	72	373348	98	941192
46	97336	73	389017	99	970299
47	103823	74	405224	100	1000000
48	110592	75	421875		
49	117649	76	438276		
50	125000	77	456533		
51	135651	78	474522		
52	140608	79	493039		
53	148877	80	512000		
54	157464	81	531441		
55	167375	82	550408		
56	175616	83	571787		

To work the laſt propoſition by the Table.

Firſt, In place of multiplying 6 cubically, finde 6 in the Table, and right againſt it you ſhall have 216, which is the cube of 6; then finde 7 likewiſe under the title Root, and under the title Cube you ſhall finde 343, the Cube of 7; then conſider, that ſo much as 216 is in proportion to 343, the like proportion 30 is to 47 pounds and ten ounces.

There is much about ſeven cube inches of iron in one pound; by this rule you may finde 7 thirty times in 216 and 7; you may finde ſeven to be contained in 343, juſt forty nine times, but this rule is not ſo perfect as the former, becauſe in ſubtracting ſeven out of 216, you ſhall finde thirty pounds and $\frac{6}{7}$ parts, which is too much by the fraction.

CHAP.

Chap. 27.

How by knowing the height and weight of one ſhot, to know the height of any other ſhot, the weight being given.

Suppoſe the height of the ſhot be three inches and three quarters, and the weight ſeven pounds five ounces; I would know what a ſhot of ſixteen pounds would be in height, according to the ſame proportion? Firſt, finde the Cube root of three inches three quarters, which you may do by the Table; then as the ſeven pounds five ounces is to the Cube of $3\frac{1}{4}$, ſo ſixteen pounds is to ſuch a Cube, whoſe root is the height of the ſhot ſought for.

Example.

By the Table I finde the Cube of three inches three quarters to be 52, and 73 hundred parts of one unit (for all the fractions are ſo many parts of one unit, the ſaid unit being divided into 100 parts) then as ſeven pounds five ounces (the weight of a ſhot of inches $3\frac{1}{4}$ diam:) is in proportion to $52\frac{73}{100}$ the Cube of inches $3\frac{1}{4}$ the height of the ſaid ſhot; ſo 16 (the weight of that ſhot whoſe height you ſeek) to 115 the Cube,

whoſe root being found in the Table, is four inches three quarters, and ſomewhat more: for in the Table, the neareſt number to 115, is 107, the juſt Cube of four inches three quarters; and this number 115 exceeding the former by eight, this ſheweth that it is a very ſmall deal higher, ſcarſe one half quarter of an inch: And you may alſo perceive by the laſt rule in the 26 Chapter, that ſeven inches cubical make a pound: now finding this to exceed 107 (the Cube of $4\frac{3}{4}$) eight cubical inches, you may conclude, that it is one pound, and one ſeventh part of a pound heavier then a ſhot of juſt four inches three quarters height.

Chap. 28.

To finde what propertion is between Bullets of iron, lead and ſtone; and by knowing the weight of one ſhot of lead, to finde the weight of any other ſhot of iron, braſs or ſtone of the like Diameter.

THe proportion between lead and iron, is as two to three; ſo that a ſhot of three pounds

pounds of lead is of the like Diameter or height as two pounds of iron.

The proportion betwixt lead and braſs, is as twenty four to nineteen.

The proportion between lead and ſtone, is as four to one; ſo that one ſhot of lead of forty pounds, is of the height as a ſtone ſhot of ten pounds.

The proportion betwixt iron and braſs, is as ſixteen to eighteen.

The proportion betwixt iron and ſtone, is as three to eight; ſo that a ſhot of thirty pounds of ſtone, is as big as the like ſhot of eighty pounds iron.

The Reader taking theſe proportions into conſideration, and having knowledge in the Art of Arithmetick, may with eaſe calculate (if iron ſhot be wanting, and the other to be had) what height and weight either ſhot of lead, braſs or ſtone, ought to be of, to fit any Piece of Ordnance: But for ſuch as are not acquainted with Arithmetick, to calculate theſe proportions, for their help I framed a Table, that doth ſhew the weight of any ſhot of lead, iron and ſtone, from two inches Diameter, to eight inches, dividing every inch into quarters.

I do

I do confeſs that ſome ſort of ſtone is much heavier then other; but ſuch as you ought to uſe, ſhould be that which is moſt compact, as Marble, Pibble ſtones alſo may be found which are round, and hard blew ſtone, ſuch as divers Tombs are made of, it being ſomewhat courſer then Marble; all theſe to my knowledge are much about that proportion as I have given: But ſuch as is ſoft, as Free-ſtone, and the like, they are not ſo pondrous as the other, nor ſo fit for uſe: Alſo lead, the finer and nearer to tin, the leſs weight it is.

You are to note, That in loading your Piece with a ſhot of ſtone, you are not to load the Piece with ſo much powder as you did formerly with iron ſhot, but abate, according to the proportion as is between ſtone and iron.

CHAP.

CHAP. 29.

A Table to finde the Weight of any shot of Iron, Lead or Stone, from two to eight inches Diameter, exactly calculated.

Inches and parts of inch	Lead. poun.	ounc.	Iron. poun.	ounc.	Stone. poun.	ounc.
2	1	10 half.	1	1	0	7
2 one quart.	2	6	1	9	0	9
2 and a half.	3	3	2	2	0	12
2 three quar.	4	5	2	14	1	1
3	5	10	3	12	1	7
3 one quart.	7	2	4	12	1	13
3 and a half.	8	15	6	0	2	4
3 three quar.	11	0	7	5	2	12
4	13	7	8	15	3	6
4 one quart.	16	0	10	10 half.	4	0
4 and a half.	18	15	12	10 half.	4	12
4 three quar.	22	5	14	14	5	9
5	2	0	17	5	6	8
5 one quart.	30	2	20	1	7	8
5 and a half.	34	11	23	2	8	11
5 three quar.	39	9	26	6	0	14
6	45	0	39	0	11	4
6 one quart.	51	0	34	0	12	12
6 and a half.	57	0	38	0	14	4
6 three quar.	62	0	42	0	15	12
7	72	0	48	0	18	0
7 one quart.	79	8	53	0	20	0
7 and a half.	87	0	58	0	22	12
7 three quar.	96	0	64	0	24	0
8	106	8	71	0	26	10

You may, if you pleaſe, look into the former Table of Cube Roots, and compare this with that; for you ſhall finde the Cube of each number bear the like proportion one towards another, as the weight of each Bullet is to another of the ſame mettal.

Example.

The Cube of $3\frac{3}{4}$ is 52 $\frac{173}{}$.

The weight of a ſhot of three inches three quarters, is ſeven pounds five ounces.

The Cube of $4\frac{3}{4}$ is 107 $\frac{117}{}$.

The weight of iron ſhot of that height, fourteen pounds fourteen ounces; which is four ounces more, then double ſeven pound five ounces; ſo likewiſe twice 52 $\frac{173}{}$ is 105 $\frac{146}{}$, which do's not exceed 107 $\frac{117}{}$ in being ſo doubled.

The uſe of this Table is very eaſie; but to make it more plain by this Example, I would know all the aforeſaid by three inches and three quarters Diam: I enter the Table under the Title inches, and parts of an inch, and right againſt it in the ſecond column, you ſhall finde a ſhot of lead of that height to contain eleven pounds: In the next you ſhall finde a ſhot of iron to weigh

weigh ſeven pounds five ounces; and in the laſt under the title Stone, two pounds twelve ounces, the weight of a ſtone ſhot of that height.

Chap. 30.

How to make a ſhot of lead and ſtone (the ſtone being put in the mould in which the leaden ſhot ſhould afterwards be caſt) to be of the like Diameter and weight as an iron ſhot is of.

I Have found by experience, That if you take five parts lead, and one part ſtone, it will come very near the matter, wanting not much above three ounces, which is nothing reſpecting the difference you ſhall finde in Pibble-ſtones: Here I have framed a Table of how much lead, and how much ſtone muſt be together, to make the equal weight of iron ſhot, from one inch to eight every half inch.

A Table

A Table *to finde how much Stone muſt be put in the mould for Leaden Bullets to make them weigh like Iron Bullets of the ſame Diam:*

Inches.	Lead. poun.	ounc.	Stone. poun.	ounc.	both t'gether poun.	ounc.
1 inch.	0	1 2/3 1/4	0	0 1/3	0	2
1 and a half.	0	6 1/4	0	1 1/4	0	8
2 inches.	3	14	0	4	1	2
2 and a half.	1	12	0	8	2	4
3 inches.	3	2	0	10	3	12
3 and a half.	5	0	1	0	5	0
4 inches.	7	7	1	8	8	15
4 and a half.	10	8	2	2	12	10
5 inches.	14	7	2	14	17	5
5 and a half.	19	4	3	12	23	0
6 inches.	25	0	5	0	30	0
6 and a half.	32	0	6	0	38	0
7 inches.	40	0	8	0	48	0
7 and a half.	48	0	10	0	58	0
8 inches.	59	0	12	0	71	0

Chap. 31.

How by knowing the weight of one Piece of Ordnance, to finde the weight of any other Piece, being of that very ſhape, of the ſame mettal, or of any other mettal, by the Table of Cube Roots.

IF the Piece be of the ſame mettal that the Piece whoſe weight you know of, you muſt do this, firſt take the greateſt thickneſs of your known Piece with your Callapers, and alſo of the Piece whoſe weight you know not; with their Diameters, enter the Table of Cube Roots; then obſerve, that as the Cube of the Diam: of the Piece (whoſe weight is known) is to the weight of the ſaid Piece, ſo the Cube of the Diam: of the Piece (whoſe weight you ſeek) is to the weight ſought for: But if the Piece be of another mettal, firſt work as before, afterwards as the difference of the mettal iron and braſs is between themſelves, ſo the weight found by the firſt rule is to the true weight ſought for.

Example.

Example.

A braſs Saker of 1900 weight, hath its greateſt thickneſs eleven inches and a half, whoſe Cube is 1520 $\frac{185}{}$ (as appeareth by the Table of Cube Roots) Now I finde the Diam: of the other braſs Piece, whoſe weight I know not, to be eight inches and three quarters; and by the Table I finde the Cube to be 669 $\frac{192}{}$, then as 1520 $\frac{185}{}$, (the Cube of 11 $\frac{1}{2}$) is to 669 $\frac{192}{}$ (the Cube of 8 $\frac{3}{4}$) ſo 1900 (the weight of the known Piece) to 837 pounds almoſt; but if the Piece had been iron whoſe weight you ſought, then having done as much as before, firſt ſuppoſing as if it were braſs, finde the difference of the mettals in Chap. 28. and the difference between iron and braſs, will appear to be as 16 to 18, braſs being the heavier; then ſay, as 18 (the weight of braſs) is to 16 (the weight of a Piece of iron of the ſame bigneſs) ſo 837 (the weight of a braſs Piece) is to 744, the weight of an iron Piece of the like ſhape and magnitude.

Chap. 32.

How by knowing what quantity of powder will load one Peece of Ordnance, to know how much will load any other Peece.

THis Chapter or Propoſition is reſolved almoſt like the former, for firſt you muſt find the Cube Root of the diameter of the bore of that Peece, whoſe allowance of Powder for a charg you know: and alſo the Diameter of the bore of the Peece, which you would know how much ſhould load, or charge it, then by the Table finde their Cubes, and as the cube of that you doe know, is to the cube of that you know not, ſo the quantity of powder known, is to that ſought for.

Example.

A Saker of three inches three quarters diameter of the bore requires foure pound

what will a Demicannon of ſix inches and an halfe require? the cube of three and three quarters is 52 and 73 hundred parts of an unite, and the cube of ſix and a halfe is 274, and 62 hundred parts: Then ſay evermore, as 52. 73 (the cube of three and three quarters) is to 274, and 62 hundred parts, (the Cube of ſix inches and an halfe) ſo foure pound of Powder to load a Saker, is in proportion to 20 pound 13 ounces the Powder to load a Demicannon. You are likewiſe to underſtand that the Demicannon ſhould be fortified ſo well as the Saker: the cube of the diameter of the Demicannon is 274, of the Saker 52, the weight of the Saker 1600, what ſhould the weight of the Demicannon be; then ſay as before, as 52 (the cube of the bore of the Saker) is to 274 (the cube of the Demicannon bore) ſo 1600 (the weight of that Saker) is to 8431, the weight that ſuch a Demicannon ſhould be of, that can beare ſuch a proportionable charge, according to the Saker: But ſuppoſe the Demicannon to be no more then 6000 weight, then you muſt multiply 6000 by 20 pound and 13 ounces (the charge already calculated) divide by 8431 the weight, and

you

you ſhall finde 14 pound 13 ounces, which is a ſufficient charge for that Peece: thus you are always to take care of over-loading your Peece, which errour divers run into, when they call a Peece a Demicannon, they preſently load her, with ſo much, as is allowed for ſuch a Peece ſo named, ſeldome examining, whether the Peece have mettall enough, for ſuch a charge; by which miſtake, they ſtand in danger of their own lives, and others too, which are about them; which may eaſily be prevented, as is above declared.

Chap. 33.

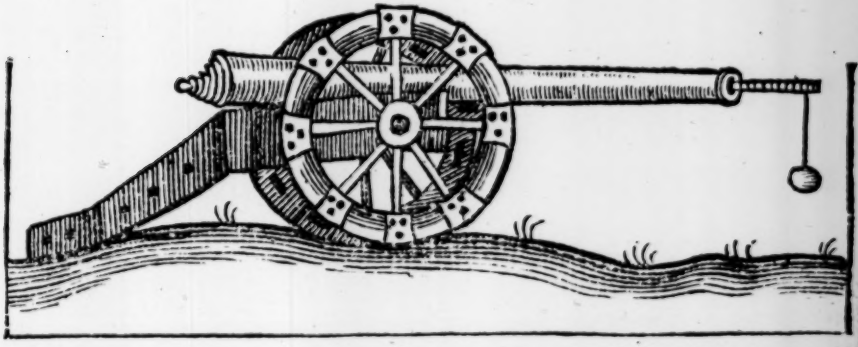
To finde whether a Peece of Ordnance be true bored or no.

YOu muſt provide a Pike-ſtaffe, about a foot longer then the bore of your Peece; and at the end thereof faſten a Rammer head, that will juſt fill all the bore under the touch-hole, and at the other

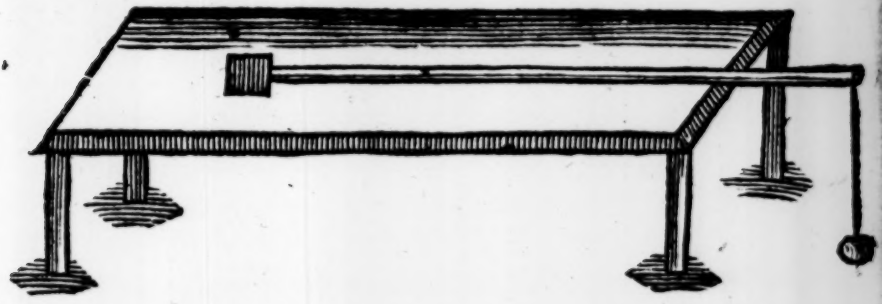
end of the ſtaffe you muſt bore a hole, big enough to put thorow a rod of iron, which muſt hang from the ſame; and at the other end of the rod, muſt be made a weight about the bigneſſe of a Saker ſhot, this is done, to make the pikeſtaffe and rammer head, to lye with the ſame part upward, when they are taken out of the Peece, as they did, when the were within the Peece: then you muſt put your Inſtrument, thus prepared, into the Peece; letting the iron ball (that is at the end of the rod, which is put thorow the hole, bored acroſſe the pike ſtaffe) hang perpendicular; then take your priming Iron, or ſome other Bodkin, and put it down the touch-hole, to the rammer head; making a mark therewith, this done, draw out your Inſtrument; and lay the ſame on a long table, with the Iron ball hanging off the end, perpendiculer: as it did when this Inſtrument was in the Peece, then obſerve whether the marke you made upon the rammer head, when it was in the Peece, be juſt on the upermoſt part of the ſame, if it be; the bore at the Peece lyeth neither to the right, nor left hand; if you finde it a quarter of an inch on the right, or left hand; ſo much lyeth the bore either

to

The Figure of the Inſtrument within the peece, and of the iron ball hanging at the end of the ſtaffe, that afterwards when it is laid on a Table, by help of the ball, it may lie with that part upwards as it did in the peece.



The Figure of the Inſtrument laid upon a Table, that by help of the ball of iron, hanging perpendicular at the end of the Table, it may repreſent how the Inſtrument lay in the Peece, and whether the Rammer head be touched or marked on the upper part or not: the Inſtrument lying (when marked) in the peece,



Place theſe two Figures folio 69 in great F.

to the right, or left; and the Peece in ſhooting muſt be ordered & charged accordingly.

By this aforeſaid, you may finde whether the bore incline to the right or left: but to know whether it ly alſo upwards and downwards, and not in the middle, that way: To know this finde the diameter of the Peece at the touch-hole, as is before taught; then take a wire and bend it a little at the very end, that it may catch at the mettall, when you draw it out of the ſaid touch-hole: after this wire is thus prepared, firſt put it in at the touch-hole, till it touch the bottom of the mettall in the Chamber, then holding it in that place, make a mark upon that wire, juſt even with the ſaid touch-hole, afterwards draw up the wire untill it catch at the mettall on the top of the Chamber, and holding it there make a mark as before; the difference between the two marks is the juſt wideneſſe of the Chamber, and the diſtance betweene the firſt mark, and the end of the wire (having half the diameter of the Chamber of the Peece ſubſtracted from it) will leave halfe of the diameter of the Peece, if the Peece be true bored, but if this number be more then halfe the diameter,

then the bore lyeth too far from the touch-hole, and the upper part of the mettall is thickeſt; but if leſſe, the under part hath moſt mettall.

Example.

Firſt, I finde the diameter of the Peece to be 12 inches at the touch-hole, then with my wire I finde the bore to be in diameter four inches: to the bottome of the mettall it is ſeven inches and an half; the half of the diameter or bore is two inches: which being added to the diſtance from the ſecond marke on the wire, or ſubſtracted from ſeven inches and an halfe the firſt marke; leaves five inches and an halfe, which is leſſe then halfe of the diameter you firſt took, by half an inch: therefore as I ſaid before, the greateſt part of the mettall is under the bore, and the Peece likeſt to break above, alſo when you make the diſpart for that peece you are to make it halfe an inch ſhorter then before, the like obſervation you muſt have to make it longer, in caſe the mettall be thickeſt in the upper part.

Thus I hope I have given reaſonable ſatis-

tisfaction concerning this point, and I am ſure on that manner as was never taught before: the truth is, there was never any way taught before that could performe this thing, the peece lying in its carriage; and how laborious it is to handle a great peece out of a carriage, let Gunners judge: I made two ſuch Inſtruments as are taught by Maſter *William Bourne*, in his Book, called *The Art of ſhooting in great Ordnance*, *Chap.* 2. but neither I, nor I believe himſelf, could ever uſe them, when the peece is in its cariage.

CHAP. 34.

A deſcription of all ſorts of Ordnance from the Cannon, to the baſe: of their weight, loding, ſhot, and all other things apperteining to them.

Of the Canon.

A Cannon is eight inches diameter in the bore, ſhe is alſo commonly 8000 weight, and about 12 foot long, the

load of Cannon powder is two diameters of powder, which is 32 pound eight ounces: the ſhot ſeven inches and an half high, weyeth 58 pound: the length of the ladle 24 inches, and the breadth thereof 14 three quarters.

Of the Demicannon.

Demicannons of the greateſt ſize are ſix inches three quarters in diameter of the bore, the ſhot ſix inches and five eight parts of an inch in height, weighing 36 pound; the weight of the peece 6000 pound; and in length 12 foot: and requireth for its charge in Cannon powder 18 pound, being neere the filling two diameters of the peeces bore; the length of the ladle 23 inches, lack one quarter, and the bredth 12 inches.

The ordinary Demicannon, the height of the bore is ſix inches and an halfe; the height of the ſhot ſix inches and one ſixth part, the weight of the ſhot 32 pound, the weight of the peece about 5600 pound; the peece is in length about ten or eleven foot; and

and her charge in powder is about 17 pound and 8 ounces: the length of the ladle is 22 inches, and the breadth thereof twelve: Another ſort of Demicannon, are in diameter of the bore ſix inches and a quarter; the height of the ſhot ſix inches, the weight 30 pound; the weight of the peece 5400, the length ſomtimes twelve, ſomtimes ten, the charge in powder, 14 pound: the ladles length 20 inches, the breadth eleven and an half.

Culverings.

Culverings of the largeſt ſize diameter of the bore five inches and an half, of the ſhot five inches and one quarter, the weight of the ſhot twenty pound, of the peece 4800: their length ten, twelve, or thirteen foot, their charge in powder twelve pound eight ounces; which is neer two diameters and an half of powder, the length of the ladle neer ſixteen inches, the breadth ten.

Ordinary whole *Culvering*, the height of the mouth of the peece five inches and one quarter; the height of the ſhot five inches, the weight ſeventeen pound five ounces; the weight

weight of the peece 4500: the length of the peece twelve foot, the load in powder eleven pound six ounces, the length of the ladle fifteen inches, the breadth nine and an half; with such a peece as last named, I found at the leagure before *Worcester*, that it carrieth 400 yards point blank, & 800 by the mettall.

Calverings of the least size, the height of the bore five inches, the height of shot four inches, and three quarters; the weight almost fifteen pound; the weight of the peece 4000: the length twelve foot, the charge of it in powder ten pound, which is much about two diameter and an half, of the bore full: the length of the ladle fourteen inches, and one quarter, the breadth ninth.

Demiculverings.

The elder sort of *Demiculverings*, the height of their bore is four inches and three quarters, the height of the shot foure and a half; the weight twelve pound and an eleven ounces, the weight of the peece 3000, the length sometimes ten, twelve, or thirteen,

the

the charge forth this peece 8 pound and an half; the length of the ladle thirteen and an halfe, the breadth eight and a halfe.

The ordinary *Demiculvering*, the bore foure inches and an halfe, the ſhot four and one quarter, the weight ten pound and ten ounces and half; the uſuall weight of the peece 2700: the length ten foot, requireth for her charge in powder ſeven pound and one quarter; the length of the ladle twelve inches three quarters, the breadth eight inches.

Demiculvering lower then ordinary, the height of the bore foure inches and one quarter; the height of the ſhot foure inches; the weight nine pound, the peece 2000 weight: the length nine or ten foot, their charge in powder ſix pound and a quarter: the length of the ladle twelve inches, the breadth eight.

Sakers.

Some *Sakers* of the oldeſt ſort, caſt in the reign of *Henry* the eighth, and *Edward* the ſixth, are 4 inches in height at the mouth, the

the ſhot 3 inches 3 quarters, the weight of the iron ſhot 7 pound 5 ounces, the weight of the peece 1800, the lengrh either 9 or 10 foot, and requireth for her charge in Cannon powder 5 pound, it being found by experience to be ſufficient, the length of the ladle 11 inches, and the breadth 7 and a quarter.

Sakers ordinary, the diameter of their bore three inches three quarters, height of the ſhot 3 and an halfe, weight ſix pound, weight of the peece 1500, length 9 foot, charge of cannon powder 4 pound, length of the ladle 10 inches and an halfe, the bredth 6 and three quarters.

Sakers lower then the former, the diameter of the bore 3 inches and an halfe, the height of the ſhot 3 and a quarter, the weight 4 pound 3 quarters, the weight of the peece 1400, the length 8 foot, and burneth in powder 3 pound 6 ounces, the length of the ladle 9 and 3 quarters, the bredth 6 inches and an halfe.

Minions.

Minions.

Minions of the largeſt ſize, are three inches and a quarter Diameter in the mouth, the ſhot 3 inches, the weight 3 pound and three quarters, but it were better if the ſhot were 4 pound weight, then it would not have too much vent, as one of 3 and 3 quarters hath, the weight of the peece 1000, ſomtimes 800, the length 8 foot, comporteth in powder, if of 1000 weight, 3 pond and a quarter, if of 800, 2 pouud and an halfe, length of the ladle 9 inches, the bredth 5.

The ordinary *Minion*, the mouth 3 inches high, the ſhot ſhould be 3 inches wanting halfe a quarter, the weight 3 pound and a quarter, the weight of the peece 750, the length 7 foot, the charge in powder 2 pound and an halfe, the length of the ladle 8 and a halfe, the bredth 5.

Faucons.

Faucons.

The height of the mouth of the peece 2 inches 3 quarters, the height of the ſhot 2 inches and $\frac{5}{8}$ the weight, 2 pound and an halfe, the weight of the peece 750, the length 7 foot, it burneth in pouder 2 pound and a quarter, the length of the ladle 8 and a quarter, the bredth of the plate 4 inches and an halfe.

Fauconets.

The mouth of the peece is 2 inches and a quarter high, the ſhot 2 inches and halfe a quarter high, the weight of the ſhot one pound 5 ounces, the weight of the peece 400, the length 6 foot, the charge one pound and a quarter, the ladles length 7 and an halfe, the bredth 4 inches.

Rabanet.

The *Rabanet* hath in diameter at the bore one inch and an halfe, the height of the ſhot one

one inch and $\frac{18}{}$ the weight 8 ounces of Iron, and of Lead 12, the weight of the peece 300, the length 5 foot and an halfe, the charge in powder three quarters, the length of the plate of the ladle 4 inches and a quarter, the breadth 2 and an halfe.

Base.

The diameter of the bore of this small peece is one inch and a quarter, the height of the shot one inch and halfe a quarter, the weight 5 ounces of iron and 8 of lead, the weight of the peece 200, the length 4 foot and a halfe, length of the ladle 4 inches, plates bredth 2 inches.

In all this *Chapter* I have made the ladle but three diameters of the shot in length, and three fifth parts of the circumference: From the *Cannon* to the whole *Culvering*, I allow the charge of powder to be about two diameters of the peece: From the *Culvering* to the *Minnion*, the charge to fill two diameters and an halfe: All from the *Minnion* to the *Base*, three diameters full of powder.

CHAP.

Chap. 35.

Of iron Ordnance, what quantity of powder to allow for their loding.

First, you muſt calculate a charge of powder for the ſaid iron peece, as if it had been a braſſe peece, and in caſe you have not the weight of the ſaid iron peece, you muſt finde it as you are taught in *Chap. 31* of this book, when you have found as I have taught in *Chap. 32*, how much powder would load the ſame if it were of braſſe, then juſt three quarters ſo much is ſufficient to load an iron peece.

Example.

A braſſe *Saker* of 1500 weight, requires foure pound, what will an iron *Demiculvering* of 2800 weight require, you ſhall finde that ſuch a *Demiculvering* of braſſe would have required 7 pound and an halfe as in *Chap. 32.* as thus, the Cube of the bore of a *Saker*, three inches and three quarters, is 52$\frac{73}{}$ of the bore of a *Demiculvering* foure inches

inches and a half is 91 $\frac{12}{}$; then if 52 $\frac{73}{}$ require foure pound, what will 91 $\frac{12}{}$ require (the cube of the *Demiculvering*) you ſhall finde ſix pound 15 ounces, ſo much ſhall ſerve for a braſſe peece, if ſo well fortified as the Saker, the which we will likewiſe examine, as 52 $\frac{73}{}$ (the cube of the Saker bore) is to 91 $\frac{12}{}$, the cube of the Demiculvering bore) ſo 1500, the weight of the Saker, is to 2592, the weight that ſuch a Demiculvering ſhould be of, that burneth ſix pound 15 ounces of powder: to finde what a Demiculvering of braſſe of 28 hundred will require ſay thus, if 2592 require ſix pound 15 ounces, what will 2800 aske? multiply, and divide, and you ſhall finde 7 pound 8 ounces; of which number you muſt take three quarters for a charge for the ſaid Iron *Demiculvering*, being 5 pound ten ounces a ſufficient quantity to load ſuch a peece withall.

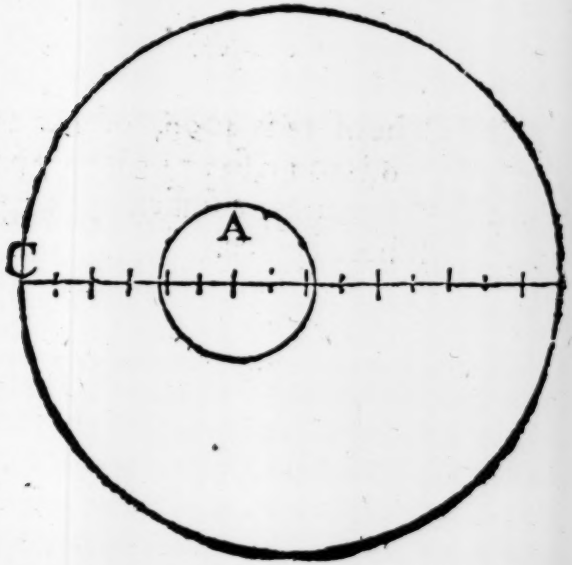
Alſo what ever you finde in the 34 *Chapter* for Braſſe peeces, take three quarters thereof for the charge of your Iron peece, if it be neer that weight.

Chap. 36.

To know what quantity of pouder ſhould be allowed to a Peece not truly bored.

Suppoſe the diameter of the mettall of the Peece at the touch-hole be 16 inches, and the diameter of the bore five and a quarter, the weight of the Peece 4850; or as you may find by *Chap.* 31. ſuch a peece you may find by *the Rule of Proportion*, in the 32 *Chap.* requires eleven pound for her due charge, being neer two diameters of her bore in powder: by my Inſtrument ſpoken of before, I try whether ſhe be true bored, and by the mark on the Tampion, at the end of the pike, I find the ſole or bore to be one inch out of his place, or one inch from the middle of the mettall, then I conclude, that the thinneſt part of the mettall, is inches 4 three eight parts: and the thickeſt ſide 6 three eight parts: by which it appears that one ſide is juſt two inches thicker then the other ſide, as you may ſee plainly by this figure, where the line divided being the diameter;

meter; every diviſion ſignifieth one inch; the outward circle the out ſide of the mettall of the Peece; the inner circle ſignifieth the borer which you may ſee to lye juſt one inch from his true center, of the out-moſt circle; how to calculate a charge for this Peece you ſhall preſently underſtand; you muſt ſuppoſe as if this Peece were fortified no more, but onely ſo much, as the thinmoſt part of the mettall is: which here will appeare to be 4 inches and three eight parts of an inch, and the half of the diameter you ſhall find by adding half, that of the



bore 2 five eight parts, to the aforeſaid number, to be juſt ſeven inches from A: the center of the bore in the figure to C the thinneſt part of the mettall the whole diameter being 14: the ſecond diameter being found is the true diameter, which you muſt proportion your charge by: the former being 16 inches, if the bore had been placed in the true center: Then as the cube of 16, is to the cube of 14, ſo eleven pound of powder, (being the charge calculated before for a peece of 6 inches diameter) is to ſuch a charge as ſhall ſuffice.

Example.

The Cube of 16 is 4096, of 14: 2744, then as 4096, is to 11, ſo 2744, is to 7 pound and almoſt 6 ounces, a ſufficient charge for ſuch a falſe bored peece.

Chap. 37.

How to make Cartredges for Ordnance, and how to fill them by help of an inch Rule, to ſo many pounds and ounces as you pleaſe.

TO make your *Cartredges*, take canvas, ſuch as the powder will not creep thorow, and let it be in bredth (I mean that peece of cloth wherewith you will make one *Cartredge*) juſt three diameters of the Chamber of the Peece in bredth: and for the length you will finde it by the filling of them, theſe being ſewed together upon a mould; which muſt be a very little leſſe then the diameter of the bore, and about 4 diameter long, upon this you may make paper *Cartredges* alſo: when they are made; yea are to fill them by the helpe of thoſe two Tables following; the one ſhewing how much powder will fill one diameter of the bore of the Peece, and the other how far in height of an inch Rule you muſt fill with powder, to make either one pound,

two

two or three pound, as the title on the top will ſhew you: you may uſe that of theſe two ways, as ſtands beſt with your convenience; and beſt befits your uſe: If you are to fill *Cartredges* for a *Demicannon*, and you finde that the *Demicannon* is able to beare two diameters of powder in her load, by this Table over againſt *6* inches and an half *Demicannon* diameter: you ſhall finde eight pound, eleven ounces and an half; to fill one diameter of the ſaid peece: the double of which is 17 pound and 7 ounces, a fit charge for the peece.

If you fill a *Cartredge* for a Saker with five pound of powder; to know how full 5 pound will make it looke in the ſecond Table, and firſt againſt three and three quarters Saker bore, you ſhall find 3 pound will fill *6* inches and 3 quarters, in height of your *Cartredge*, and two pound more will fill 4 inches, and an half; which being added together, ſhews that your *Cartredge* is to be fitted juſt eleven inches, and one quarter for 5 pound.

The

The Table of Diameter.

The first Table shewing how much cannon powder will be contained in one diamet. of the bore of any powd.

Inch. parts	Pound oũ
2 0	0 4
2 1.4	0 6
2 1.2	0 7 3.4
2 3.4	0 10 1.2
3 0	0 13 1.2
3 1.4	1 1 1.2
3 1.2	1 5 3.4
3 3.4	1 10 1.2
4 0	2 0 1.2
4 1.4	2 7 1.2
4 1.2	2 14
4 3.4	2 6 1.4.
5 0	3 15 1.2
5 1.4	4 9 1.2
5 1.2	5 4 3 4
5 3.4	6 0 3 4
6 0	6 13 3.4
6 1.4	7 12
6 1.2	8 11 1.2
6 3.4	9 12 3.4
7 0	10 14 1.2
7 1.4	12 2
7 1.2	13 6 1.2
7 3.4	14 12 1.2
8 0	16 4 1.2

The Table of Pounds.

The second Table sheweth how far either one two or three pound of powder will fill in the bore of any Peece, the Diameter of the bore being given.

Inch. part	Inch. part	Inch. part	Inch. part
2 0	8	16	24
2 1.4	6 1.4	12 1.2	18 3.4
2 1.2	5	10	15
2 3.4	4 1.6	8 1.3	12 1.2
3 0	3 1.2	7	9 1.2
3 1.4	3	6	9 0
3 1.2	2 5.8	5 14	7 7.8
3 3.4	2 2.4	4 1.2	6 3 4.
4 0	2	4	5 7.8
4 1.4	1 3 4	3 1.2	5 1.4
4 1.2	1 1.2	3	4 5.8
4 3.4	1 3.8	2 3.4	4 1.8
5 0	1 1.4	2 1.2	3 3.4
5 1.2	1 1.16	2 1.8	3 3 16
6 0	0 14.16	1 3.4	2 3.8
6 1.2	0 12.16	1 1.2	2 1.4
7 0	0 10.16	1 1.4	1 15.16
	1 Pound.	2 Pound.	3 Pound.

Whereas Fractions usually are placed one figure over the other, with a line between them, in this Table they are placed one by the side of the other with a point between the Numerator and Denominator; as thus, 1.2 signifying one halfe, 5.8 five eight parts, &c.

To fill *Carteredges* for Minion, 3 pound; look in the ſecond Table, and in the Collume of 3 pound; you ſhall have (right againſt 3 inches and one quarter Minion bore) 9 inches juſt, to be the height of the powder in the *Cartredge*, for the loading that Minion 3 pound.

To fill for a *Demiculvering*, which requireth 2 Diameters and an half for his charge; look in the firſt Table, right againſt 4 inches and an halfe, you ſhall find 2 pound 14 ounces; to fill one Diameter of the ſaid Gun: which being doubled maketh 5 pound and 12 ounces, and one half Diameter alſo added to that; maketh the Charge to be 7 pound 3 ounces.

Now having fully ſhewed how to make powder, to try the ſtrength of powder, to know what ſhot and powder is meet for every Peece: to finde whether the Peece be true bore or not, to load a peece with diſcretion if not true bored: to make the diſpart: and alſo to know the difference between Iron and Braſſe peeces: I ſhall come to touch how to make a good ſhot, either at point blank, or at randon; with as much eaſe and plainneſs, as ever was before taught by any whatſoever.

Chap. 38.

How to give levell with a peece of Ordnance, to make a ſhot at any mark aſsigned, within point blank.

SEt your diſpart on the *Muſſell ring*, juſt over the center of the mouth of the peece; which you may beſt doe, by putting a ſtick acroſſe the bore, and dividing it into two equall parts, then with a plumb line hanging over the mouth of the Peece, being guided by the divided ſtick, you ſhall have a good ayme, where to ſet your diſpart; this being done, go to the Baſe ring, if the Peece be true bored, then finde out which is the higheſt part, and middle of that ring, but if the Peece be not true bored, then finde which part of the Baſe ring, is juſt over the Cylinder; and take that for your true line. When you have found out both the Diſpart, and placed it, and alſo found what point in the Baſe ring is to anſwer it, then make ſome very ſmall mark on the

Baſe ring in that place, hold your head about two foot from the Baſe ring, and there you may beſt obſerve, as the Peece is traviſſing, when you are in a direct line with the Mark, this being done, give one of your Matroſſes order, to raiſe, and fall the Peece with his Hand-ſpike, as you ſhall appoint him, untill you can holding your head about two foot from the Breech of the peece) with your eye perceive the marke at the Baſe ring, and the top of the Diſpart in a direct line with the Marke you muſt ſhoot at: at that inſtant ſtop the motion of the Peece with a Coyne, that it may remain as you have directed it: Then prime the Peece and give fire.

Before you place on your Diſpart, you are to obſerve whether the ground be levell, on which the wheeles of the Gun ſtand, if they are not one higher then the other: If the Trunnions are placed juſt over the Axtree of the Wheeles or not: Whether one Trunnion lye higher on the Carriage then the other: Whether the Gun be truly placed in the carriage or not; I mean not ſwerving more to one ſide then the other: Whether the ſaid Carriage be truly made or not:

And

And laſtly, whether the Axtree be placed juſt a croſſe the Carriage or not.

How the Carriage of a Peece ſhould be made.

Meaſure the length of the Cylinder of the bore, and once and an halfe that length ſhould be the length of the Carriage: Alſo meaſure the Diameter of the bore of the Peece, the Planks ought to be foure of thoſe Diameters in depth at the fore end, in the middle three and an halfe, and at the end next the ground two and an halfe, alſo they ought to be in thickneſſe one Diameter: The wheeles ſhould be one halfe the length of the Peece in height, the Saker and Minnion wheels muſt exceed the former by one twelfth part; the Faucon and Fauconet, by one ſixt part.

If you finde that the ground is not levell, on which your Peece ſtands, and that one wheele is higher then the other, and the Trunnions out of due place, the Peece not lying truly in the Carriage, and that alſo not truly made, you muſt get theſe things amended, or elſe never looke for good ſervice from ſuch a Gun, being ſo ill planted.

Chap. 39.

How if the firſt ſhot (by reaſon of ſome fault ſpoken of in the laſt Chapter) doe carry to the right, or left, or over, or under the Mark, to amend it in the making the next ſhot.

After you have made one ſhot, and finde the Peece carry juſt over the Marke, then doe all as hath been before taught again, and when as your Peece lies directly againſt the Marke, obſerve how much the laſt ſtrock of the ſhot is above, the Marke, ſo much longer make your Diſpart, that the top of it may be juſt ſeen from the Britch of the peece in a direct line with the ſtrock of the ſhot, when it is of this length, then levell your Peece with this new Diſpart, to the aſſigned Marke: Give fire, and without doubt it will ſtrike the ſame.

If the firſt ſhot had ſtruck under the Mark, then

then bring the Peece in all points as before to paſſe, marke how much of the Diſpart is over the ſtrock of the ſhot, and cut it juſt ſo ſhort, as being at the britch you may diſcern the top of it, the marke on the Baſe ring, and the ſtrock of the ſhot in a right line, when you perceive it is of ſuch a length, levell the peece to the aſſigned marke as at the firſt, then prime and give fire.

If the firſt ſhot had ſtruck on the right hand of the Marke, to mend it, you muſt levell the Peece as formerly, you ſtanding behinde the britch of the Peece, obſerve the ſtrock of the ſhot over the Diſpart, that part of the Baſe ring as you at that inſtant looke over in a right line towards the Diſpart, and the ſtrock of the ſhot, ſet up in that place a pin with a little ſoft wax on the Baſe ring, ſo this pin will be in a right line with the Diſpart and ſtrock of the ſhot: this being done, levell your Peece to the Marke aſſigned, by this pin and the Diſpart, and without queſtion you will make a faire ſhot.

For when you levell by the mettall of the baſe ring where the pin is placed and the marke, the peece ſtanding at that direction, looke over the top of the Diſpart, from the

notch in the Baſe ring, and you ſhall finde the peece to lie juſt ſo much to the left, as the former ſhot ſtruck to the right from the aſſigned marke, which ſhould in all likelyhood now ſtrike the marke.

But if the ſhot be both wide and too low, then you muſt uſe both directions above taught, to make the next ſhot: Firſt regulate the Diſpart by cutting it ſhorter, according as the ſhots marke is lower then the aſſigned Marke; when this is done, then proceed to my directions to mend ſhooting wide. Theſe things done with care and diligence, cannot chooſe but mend a bad ſhot.

Chap. 40.

Of the Gunners Quadrant, which is to be uſed in ſhooting at Randon, and what portion the Degree of a Quadrant is.

You are to underſtand that every Circle great and ſmall is divided into 360 Degrees, the cauſe of this di-

diviſion is, becauſe the Sun maketh his motion in little more then 365 dayes, through the *Zodiack* or twelve Cœleſtiall Signes, which is a Yeare; now 360 is the next even number that can be divided into quarters and halfe quarters, fit for uſe, and the Sun dividing his Circle thus, does give example to all Mathematicians to divide all accordingly, a quarter of which Circle we call a Quadrant, containing 90 Degrees, you muſt have a ruler faſtened to one ſide of ſuch a quarter of a Circle or Quadrant, that muſt be put within the concave of the Peece, with a piece of lead at the end, to make the ſaid rule lie cloſe to the bottome of the mettall within, the Quadrant hanging without, by the plumb-line you ſhall find how many of thoſe Degrees the Peece is elevated unto, and the Quadrant being thus placed, you may mount the Peece to what Degree you ſhall finde fit to ſhoot by.

I will not make any figure of a Quadrant, or give other directions for the making of it, becauſe they which want one may buy it in divers places in *London*, but will proceed to teach the uſe thereof in Gunnery.

Every one that will learn to ſhoot at Randon,

don, muſt draw his Peece into a levell ground, where firſt ſhooting levell, he muſt obſerve that diſtance in feet or paces, then mouut his Peece to one Degree, and marke where that ſhall graze: thus finde the diſtance of every Degree, from the levell to the 10^{h}. Degree, and by theſe diſtances make a Table, to which annex the Degrees againſt the diſtances, by which Table you may (uſing the Art of proportion) finde how far another Peece will convey her ſhot from Degree, to Degree: But in caſe you cannot have liberty, nor pouder to doe all the aforeſaid, I will tell you what I have done my ſelfe, out of a Saker eight foot long, loded with three pound of pouder, at the firſt ſhoot being one degree mounture, it conveyed her ſhot 375 yards, or 225 paces: the next ſhot was at five Degrees Randon, at which mounture ſhee conveyed 416 paces, and the next tryall was at ſeven Degrees mounture, the Randon produced 505 paces, the laſt tryall was at ten Degrees, which conveyed 630 paces, five foot to a pace.

Whilſt I made theſe ſhots I loded the Peece my ſelfe with looſe pouder exactly wey-

weyed, and weyed the wad, alſo I beat down the ſaid wad with foure ſtroaks, ſo neere as I could with the ſame ſtrength I did the time before, alſo I let the Peece cool of it ſelfe, ſtaying above halfe an houre betwixt each ſhot, I put no wad after the bullet becauſe the Peece was mounted, I am ſure if I had not taken all this care, I ſhould not have profited by all theſe ſhots: When theſe were made, I tryed the ſtrength of the pouder, the which I carefully noted down, alſo I kept ſome of it to compare again, when I ſhould have other pouder, theſe things I would adviſe every one to obſerve, that meaneth to be cunning in ſhooting at Randon.

It is the duty of a Maſter Gunner of a Town or Fort, to draw an exact deſcription of the ſaid Garriſon, and of every object as lyeth neer his Works within the reach of his Guns, by which means he ſhall not be troubled to take the diſtance, but be ready at all times to know the diſtance by his Map: then after he hath made one ſhot, he by the *Rule of Proportion* may be able to make another ſhot to any diſtance he pleaſeth, *exãple*, ſuppoſe I find the diſtance by my Map where the

the firſt ſhot grazed, to be 704 paces, the mounture of the Peece being foure degrees, how much muſt I mount the peece to convey her ſhot 900 paces, you muſt proportion theſe diſtances of Randon to thoſe in my Table; ſay, if 407 paces require 370 paces, (as the Table hath it at foure Degrees of Randon) what number to be found in the Table, againſt that Degree which I muſt mount the Peece unto will 900 require. Multiply and divide, and you ſhall finde 473 which number is not to be found in the Table; but the next leſſe is 461, againſt ſix Degrees, and the next greater number is 505, againſt ſeven Degrees, the difference between theſe two numbers is 44, which ſhew that the Peece muſt be mounted at ſix Degrees and one third part, for to reach the diſtance of 900 paces, becauſe 461 is 12 leſſe then 473, it being one third part almoſt of 44 the difference.

Here

Here I preſent unto your view the Table of Randons which I made by my own obſervation, deſiring every one if it be poſſible he can get pouder, to make one by his own experience, and alwayes remember to keep ſome of the ſame Gunpouder to try its proportion, as I have taught in the 16 *Chap.* with any other pouder that afterwards he ſhall have occaſion to uſe, for this is one of the excellenteſt properties that belong to a Gunner, and without this knowledge he ſhall never be able to make good ſhot, becauſe at the time of a Leagure he muſt often change his pouder, at ſuch a time I have had nine pound of one ſort, as good as 15 of another ſort, as both by ſhooting, and by my Inſtrument I have experimented.

Degrees.	*Randons.*
1	225
2	274
3	323
4	370
5	416
6	461
7	505
8	548
9	589
10	630

CHAP.

the firſt ſhot grazed, to be 704 paces, the mounture of the Peece being foure degrees, how much muſt I mount the peece to convey her ſhot 900 paces, you muſt proportion theſe diſtances of Randon to thoſe in my Table; ſay, if 407 paces require 370 paces, (as the Table hath it at foure Degrees of Randon) what number to be found in the Table, againſt that Degree which I muſt mount the Peece unto will 900 require. Multiply and divide, and you ſhall finde 473 which number is not to be found in the Table, but the next leſſe is 461, againſt ſix Degrees, and the next greater number is 505, againſt ſeven Degrees, the difference between theſe two numbers is 44, which ſhew that the Peece muſt be mounted at ſix Degrees and one third part, for to reach the diſtance of 900 paces, becauſe 461 is 12 leſſe then 473, it being one third part almoſt of 44 the difference.

Here

Here I preſent unto your view the Table of Randons which I made by my own obſervation, deſiring every one if it be poſſible he can get pouder, to make one by his own experience, and alwayes remember to keep ſome of the ſame Gunpouder to try its proportion, as I have taught in the 16 *Chap.* with any other pouder that afterwards he ſhall have occaſion to uſe, for this is one of the excellenteſt properties that belong to a Gunner, and without this knowledge he ſhall never be able to make good ſhot, becauſe at the time of a Leagure he muſt often change his pouder, at ſuch a time I have had nine pound of one ſort, as good as 15 of another ſort, as both by ſhooting, and by my Inſtrument I have experimented.

Degrees.	*Randons.*
1	225
2	274
3	323
4	370
5	416
6	461
7	505
8	548
9	589
10	630

CHAP.

Chap. 41.

How to make an effectuall ſhot out of a Peece of Ordnance at Randon.

EVery one that hath charge of a Gun, muſt at one time or other obtein leave of his ſuperiours, to make two or three ſhots at leaſt out of his ſaid Peece, and meaſuring the diſtance from the Platform to the firſt graze of the ſhot, you muſt apply it to my Table, and by *the Rule of Proportion*, as in the laſt *Chapter*, finde what Degree you ſhall need to mount the Gun for any other ſhot at another time when you ſhall have occaſion.

Firſt, When you come to your Peece, ſet your Boudge barrel on the wind hand thereof, and cauſing one of your Matroſſes to hold the ſame aſlope, thruſt your Ladle into the ſame, filling it full of pouder, and then ſtrick it with a Ruler, (for by ſo doing, you may know juſt how many pounds and ounces you load your peece withall) then fixing your

your thumb juſt under the ſtaffe of the Ladle, thruſt the ſame home to the Chamber of the Peece where the pouder lyeth, turning the Ladle ſo, as your thumb be directly above the ſtaffe, and in ſo doing, the pouder will empty it ſelfe out of the Ladle cleanly, then drawing out your Ladle, with the Tampion at the other end of that ſtaffe, thruſt home the pouder, cauſing your aſſiſtant to hold his finger or thumb cloſe on the touch-hole, then taking a cloſe round wad of hey, or untwiſted rope, thruſt in the ſame with your Rammer head that is on the Spunge ſtaffe, (for if you ſhould doe it with that on the Ladle, it would ſoon looſen the plate of the Ladle) and with it give three or foure good ſtroaks, when you have thus done put in the bullet without any wad, becauſe the Peece muſt be elevated.

If you charge your peece with Cartredges, which I count the beſt way, providing, (that although they hold the like quantity of powder) they be all of one thickneſſe; otherwiſe you ſhall finde much deceit in ſhooting: ſlit it a little in that place, which muſt be conveyed under the touch-hole; then put it home with the end of the Rammer

mer, and afterwards put home to it a good wad, then turn in the ſhot, the Peece being loaded, as I have taught you, take the diſtance to the mark, by ſuch means as I teach in the 59 Chapter of this Book: and alſo obſerve, how many degrees the platform, is either higher, or lower, then your marke with your Quadrant: after you have done thus; and calculated what degree you muſt mount the Gun unto, to reach the mark, if the ſaid mark be under the platform; ſubtract the profundity, out of the degrees of randon, but if the ſaid mark be higher then the platform, add the degree of that altitude, to the degrees of Randon: and at theſe corrected degrees, mount your Peece: by putting the Ruler of the Quadrant into the mouth of your peece, marking diligently untill the plumb-line, which proceedeth from the center of your Quadrant, cut thoſe degrees and parts of a degree (unto which you are to mount the Gun) in the Circumference; Make your ſhot, for without queſtion, you may either ſtrike or come very neer the mark.

Ex-

Example.

Suppoſe that when you make triall of your Gun, as is ſpoken of in the beginning of this Chapter, you finde that at ſeven degrees of Randon upon a levell ground, the ſhot is conveyed 700 paces, you being called out upon ſervice againſt a Citie, or other Fort, and being appointed to play your Gun towards it; you alſo finding it to beyond point-blank; the diſtance being 560 paces; alſo that the ſaid place is lower then where you muſt plant your Gun, by one degree, and one ſixt part, then to know the degrees of mounture, ſay, as 700 paces (being the range of ſeven degrees, out of your Gun formerly) is to 505 (the diſtance of Randon found in my Table of Ranges for ſeven degrees) ſo 560 (the diſtance to the mark) is to 404; this number is to be found in the Table or the neereſt number unto it; and againſt that the degrees: the parts of the degrees muſt alſo be found, by ſubtracting the neereſt leſſe number, out of the neereſt great number: thus looking in the Table the neereſt leſſe number is 370, the neereſt greater

ter 416: one ſubtracted from the other the difference will be 46: 404 differeth from 416 but 12 parts, which is a little above one quarter; ſo that your degree of Randon is foure and three quarters; or five lack one quarter; becauſe the mark is lower then the platform, ſubtract one degree and one ſixt part or ten minutes out of four degrees, and three quarters, or 45 minutes; and the remayn is three degrees and 35 minutes, the true height, to which your peece muſt be elevated, to reach the mark.

If the ſhot graze either to the right or left, you are to mend it by the directions in *Chap.* 39, but if over, then you are to conſider the diſtance, how much it is beyond; and the next ſhot abate ſo many minutes out of your mountures, as the diſtance beyond the marke does require; if ſhort, you are to adde to your mounture, as if the like number of paces that you ſhall finde ſhort, had been wanting to your diſtance, then proceed as before.

Example.

Suppoſe the ſhot graze over the marke 20 paces, ſubſtract this 20 out of 560 the di-

diſtance, and mount the next ſhot according as if the marke were but 540 paces diſtant.

If 20 paces ſhort, make the next ſhot at 580 paces, I mean at that degree that will reach ſo far.

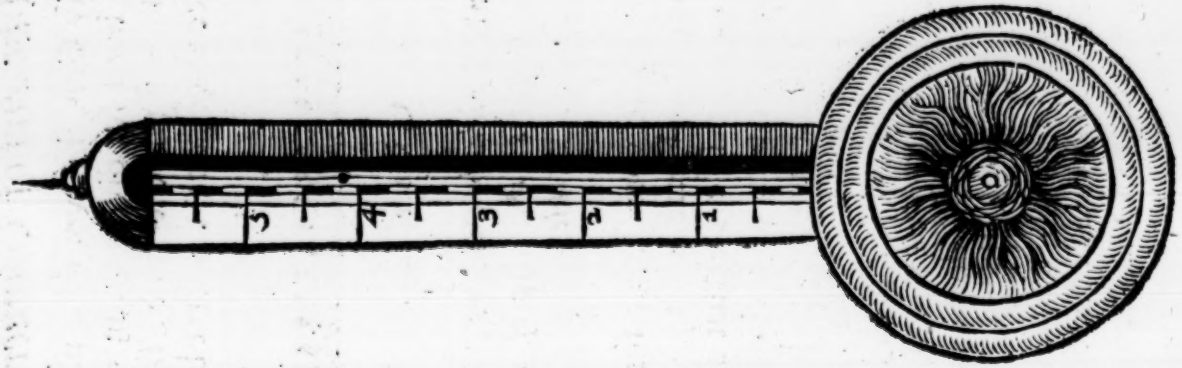
Chap. 42.

How to make another ſort of Inſtrument, called the Gunners Rule: which will ſerve to elevate a Peece of Ordnance, with more facility then the Gunners Quadrant.

BEcauſe the Quadrant afore mentioned cannot be conveniently uſed at all times, for if the winde be high, you will have very much adoe to make the plummet ſtand ſtill, beſides, it is a great trouble to take the profundity of a valley, and the altitude of a hill, when the marke is not levell, alſo in field ſervice you cannot uſe it, (but onely in a Leaguer or out of a Garriſon when it is beleagured) the plumb-line is over long before it ſtands ſtill: to remedy all

this, the Gunners Rule was invented, the figure whereof you may ſee in the following page. This rule muſt be ſome 10, 12, or 14, inches long, according as the Gun will require, it muſt have a long ſlit down the middle thereof, dividing it almoſt into two, but onely held together by a little peece at the head and the foot, which muſt be circular according to your Gun, as you may ſee in the figure, where the Inſtrument is deſcribed, ſtanding upon the britch of a peece of Ordnance: in the middle of the ſmall and narrow ſlit you muſt place a lute ſtring, and upon that a beade, which you may move up and down at pleaſure, or if you cannot get a lute ſtring, you may uſe a good thrid inſtead thereof; this bead muſt be ſet to ſuch an inch, as you finde is agreeable to ſuch a degree, that you muſt mount your Gun unto, in this figure, the bead is at foure inches and halfe a quarter: on one ſide the ſlit muſt be placed a diviſion of Inches and quarters or tenths of Inches, on the other ſide muſt be placed the Degrees and Minutes, when you ſhall finde by the length of your Gun, how many Inches and parts goes to make one Degree. If you make this Ruler for one

See here the Gunners Ruler ſtanding on the britch of a Peece.



one onely Gun, then you may place on the Degrees, but if for divers Ordnances, then you muſt not figure the ſame, for the degrees once placed on, can ſerve but for one Gun.

Chap. 43.

How to divide the Gunners Rule into Degrees, by helpe of a Table.

IF you make your Ruler for one Gun onely, I will here teach you to divide the oppoſite ſide (to that divided into Inches and tenth parts of Inches, that is every Inch divided into ten equall parts) into Degrees by the Table following, which Table is divided into 10 Columes for the ten degrees, and right before this diviſion is the length of the Gun ſet down, which you muſt enter the Table withall, and juſt againſt it you ſhall have in how many Inches and parts of an Inch doe make one degree, two degrees, three degrees, and ſo to ten degrees.

If

A TABLE by which you may place the Degrees on the *Gunners Rule*, fitting it for any Peece from five foot long to fourteen foot long, and by help of which any Peece may be levelled to any degree without the helpe of a *Quadrant*, *Ruler*, or any other Geometricall Instrument whatsoever.

The length of the Peece.	1 *deg.*	2 *deg.*	3 *deg.*	4 *deg.*	5 *deg.*	6 *deg.*	7 *deg.*	8 *deg.*	9 *deg.*	10 *deg.*
5 Foot long.	1 3	2 6	3 8	4 11	5 14	6 16	7 19	8 22	9 25	10 28
5 Foot and an halfe.	1 14	2 28	3 42	4 56	5 70	6 84	7 98	9 12	10 26	11 40
6 Foot long.	1 22	2 44	3 66	4 88	6 10	7 38	8 58	9 78	11 8	12 29
6 Foot and an halfe.	1 36	2 72	4 8	5 44	6 80	8 17	9 53	10 89	12 25	13 63
7 Foot long.	1 47	2 94	4 41	5 88	7 35	8 82	10 30	11 77	13 24	14 73
7 Foot and an halfe.	1 58	2 14	4 71	6 28	7 85	9 42	10 99	12 57	14 14	15 71
8 Foot long.	1 68	2 36	5 4	6 72	8 40	10 8	11 76	13 44	15 12	16 82
8 Foot and an halfe.	1 79	2 58	5 37	7 16	8 95	10 74	12 53	34 32	16 12	17 92
9 Foot long.	1.89	12 79	5 68	7 58	9 47	11 37	13 27	15 18	17 8	18 98
9 Foot and an halfe.	2 0	4 0	6 0	6 0	10 0	12 10	14 2	16 3	18 4	20 4
10 Foot long.	2 10	4 20	6 30	8 40	10 30	12 61	14 73	16 84	18 96	21 8
10 Foot and an halfe.	2 21	4 41	6 69	8 88	11 81	13 28	15 48	17 68	19 89	12 10
11 Foot long.	2 31	4 62	6 93	9 24	11 56	13 88	16 20	18 51	10 82	23 14
11 Foot and an halfe.	2 47	4 84	7 26	9 68	12 10	14 52	16 95	19 37	21 80	24 21
12 Foot long.	2 53	5 6	7 59	10 12	12 65	15 18	17 71	20 25	22 78	25 33
12 Foot and an halfe.	2 63	5 26	7 89	10 52	13 15	15 78	18 41	21 4	23 67	26 33
13 Foot long.	2 74	5 48	8 22	10 96	13 70	16 44	19 48	21 92	24 68	27 40
13 Foot and an halfe.	2 84	5 68	8 52	11 36	14 20	27 4	19 88	22 72	25 56	28 42
14 Foot long.	2 95	5 90	8 85	11 80	14 75	17 70	20 66	23 60	26 56	29 53

Place this Table in folio 20, little b.

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If your Gun be 12 foot long, two inches, and 53 hundred parts of an inch doth make one degree, five inches, and ſix parts, (if the inch were divided into 100) maketh two degrees, &c. For I told you before, that you muſt divide your inch into ten parts, and for more exactneſſe, ſuppoſe every one of thoſe 10 parts to be divided into ten more, which maketh 100, all thoſe parts ſet down in the Table, are ſuch parts.

Chap. 44.

How to give levell to a peece of Ordnance, with the Gunners Rule, at any degree of Randon.

THe peece being loded in all points, as is before taught, and you alſo having brought the peece in a right line with the marke, the Diſpart being placed upon the muſſle ring, place your Ruler upon the baſe ring, and having before all this, taken the diſtance to the marke, and found it to be 461 yards: the firſt ſhot you made out of that peece for

practice conveyed her ſhot 274 yards, at two degrees mounture, according to the rules before taught, 461 yards will require ſix degrees mounture, then to finde by this Table how many inches, and hundreth parts of an inch, ſix degrees will require, looke in the laſt Table, finding on the left hand, in the firſt colume the length of the peece 12 foot juſt, under ſix degrees in the common angle you ſhall find 15 inches, and 18.100 parts of an inch; which known, I ſet the bead that is on the ſtring in the ſlit to 15 inches, and 13 parts, if the inch be divided into 100, and cauſe the peece to be moved either higher or lower, untill you ſee the bead, the top of the diſpart, and the marke, all in one line, ſtop the peece at that poſition with a coyn, prime and give fire.

If you would ſhoot by the mettall of the peece without a diſpart, ſubtract the length of the ſaid diſpart, out of the inches found in the Table, and the remainer mount your peece unto: if the diſpart had beene three inches long, that taken out of the inches found in the Table being 15. 18.100. will leave 12. 18.100. to which heighth in the Rule without a diſpart, you muſt mount the peece.

CHAP.

Chap. 45.

How to make uſe of the laſt Table, to give levell to a Peece of Ordnance without the Gunners Rule.

IF you have not a Ruler nor Quadrant, and would make a ſhot juſt at five degrees elevation, looke in the Table, and finde the length of the peece, which admit to be nine foot and an halfe, right againſt this, in the angle under five degrees, you ſhall have ten inches, to be the length of any ſtreight ſtick, which you may ſet upon the baſe ring, and levell over the top of the ſaid ſtick, as if it had been the bead in the Ruler, thus you may performe as much as with the Ruler, if you will have no diſpart upon the peece, take it off, and lay it with the aforeſaid ſtick, from which cut off its juſt length, the remainer you may uſe upon the baſe ring, for when you have the top of it, the mettall of the muſſle ring, and the marke in a right line, you cannot faile of making a good

good ſhot. If the diſpart in this peece were two inches and an halfe, this cut from the length of ten inches, the number found in the Table, there will be left ſeven inches and an halfe, for the length of the ſtick, to be ſet on the baſe ring, to levell the peece without a diſpart.

Chap. 46.

How to make a ſhot at the enemies lights in the darke night.

When you ſhall have occaſion to ſhoot at a light ſeene in the night time, diſpart your peece with a lighted and unflaming wax candle, or with a lighted peece of match, that you may ſee by the light of the fire in the ſaid Gunmatch, to lay the middle and upmoſt part of the mettall, at the tayle of the peece; the top of the match, and the marke in one line, when this is done, give fire.

Chap.

Chap. 47.

How to make a perfect ſhot in a darke night, at any marke that may be ſeen in the day time, within the reach of the Peece.

IN the day time mount your peece (as you are before directed) to reach the appointed marke, and at that time place the mouth or concavity of the peece right upon the ſaid marke, then put the ruler that is fixed to the Quadrant into the mouth of the peece, note what degree is touched in the Quadrant by the plumb-line, and ſet it down in writing, or elſe keepe it in memory, after that, let fall a line and plummet down to the ground, from the middle part of the mouth of the peece, in the place where the plummet, toucheth the platforme make a marke, then carry your line and plummet to the breech of the peece, and let it hang to the ground, from the middle part of the breech,

breech, there alſo where it toucheth the ground or platforme likewiſe make another marke: betweeneach, oftheſemarks draw a line, and continue that line above two yards beyond each marke, this ſhall be called the line of direction. Now when you will ſhoot in a darke night with that peece at the ſame marke; charge the peece with the ſame quantity of pouder; as you did when you found by experience that ſuch a degree wch you now muſt mount by, did hit the mark, and alſo with the like weight of ſhot, then bring your gun upon the line of direction, ſo that the middle of the mouth of your peece, and middle of the breech may be juſt over it, which you may bring to paſſe by help of the plummet, when this is done, elevate the peece ſo much by the Quadrant, as you did in the day time, and without queſtion ſhee will reach the marke as before.

CHAP.

Chah. 48.

How to make a perfect ſhot at a company of horſmen, or footmen, paſsing by the place where Ordnance do lye upon a levell ground, and alſo to make a good ſhot at a ſhip ſayling up a River.

When any horſmen or footmen ſhall paſſe by a place where a great peece of Artillery doth lye, the Gunner muſt charge the peece before-hand, with good powder, and fit ſhot, to this end that the peece may goe off ſo ſoone as fire is put to the ſame: alſo the Gunner in this caſe muſt lay his Gun truly diſparted upon a levell ground, right againſt ſome marke in their way, as againſt ſome tree, buſh, or hillock, and beſt of all if it be upon ſome turning way, becauſe in ſuch a place they cannot depart very quickly, and when the ſaid horſmen or footmen, ſhall come neere unto that marke, or be in the turning way, the Gun-

Gunner muſt diſcharge his ſaid peece at them: Likewiſe when a Gunner will ſhoot at a ſhip ſayling in a river, he ought to plant his peece towards a cloud or ſome evident marke on the other ſide the river, and give fire to his peece when the fore part of the Ship ſhall begin to be between the mouth of the peece and the marke.

Chap. 49.

How to cauſe that the ſame quantity both of pouder and ſhot, diſcharged out of the ſame Peece, ſhall carry cloſe or more ſcattering.

Maſter *John Bate* in his Booke of *Extravagants*, ſayth, Take the quantity of a peaſe of *Opium*, and charge it amongſt the caſe ſhot, and it will make the ſaid caſe ſhot fly cloſer together, then otherwiſe it would, this Maſter *Bate* ſayth, he learned of a Sea man, who had made triall hereof, as he ſayes, and unto whom Maſter

te ſold ſome for that purpoſe; it is
able, for *Opium* is of a congealing
e nature.

Chap. 50.

which ſticketh faſt within the con-
a Peece, that it cannot be driven
unto the powder, may be ſhot
t without danger to the
Gunner, or hurt to
the Peece.

When a peece of Artillery is char-
ged with ſuch a Shot, as will not
be driven home unto the powder,
Gunner to ſave this peece from
muſt ſo imbaſe the mouth there-
ire water for two or three dayes,
in at the touch hole, at ſeverall
run out into a veſſell ſet under the
he Gun, to ſave all the *Salt Peeter*
the powder, when theſe things
he Gunner muſt prime the peece
much in at the touch-hole, as
will

Gunner muſt diſcharge his ſai
them: Likewiſe when a Gunner
at a ſhip ſayling in a river, he oug
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Chap. 49.

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triall hereof, as he ſayes, and

Maſter *Bate* ſold ſome for that purpoſe; it is very probable, for *Opium* is of a congealing and fixative nature.

Chap. 50.

How a ſhot which ſticketh faſt within the concavity of a Peece, that it cannot be driven home unto the powder, may be ſhot out without danger to the Gunner, or hurt to the Peece.

WHen a peece of Artillery is charged with ſuch a Shot, as will not be driven home unto the powder, then the Gunner to ſave this peece from breaking, muſt ſo imbaſe the mouth thereof, that faire water for two or three dayes, being put in at the touch hole, at ſeverall times may run out into a veſſell ſet under the mouth of the Gun, to ſave all the *Salt Peeter* that was in the powder, when theſe things are done, the Gunner muſt prime the peece and put ſo much in at the touch-hole, as will

will ſerve to drive out the ſhot. But when a rufty ſhot hath for a long time ſtuck faſt within the peece, put ſtrong Vineger in the mouth of the peece, and with the rammer ſtrike the ſhot till it doe move, then poure the Vineger out again, if it have ſoaked through the powder, then prime with a little freſh powder, and give fire, if the Vineger could not paſſe by the ſhot amongſt the powder, then moyſten the ſaid powder with ſome water or Vineger, when it is yet danke and moyſt, prime the touch-hole with good powder, and give fire.

Chap. 51.

A merry conceit, how to charge a Peece of Ordnance without Gun-powder.

This may be done with aire and water onely, having put cold water into the concavity of the peece, filling one quarter of the Cylinder, put in after it a Tampion of wood as long as broad, perfectly made to fit the peece, with an oyled cloath

cloath about it, doubled either more or leſſe, that it might be two mens ſtrength to put it home, this done, put in the ſhot, elevate the peece a little, and make a fire under the hinder part thereof, the touch-hole being very cloſe ſtopped, then put the ſpunge of the peece in oyle, and wet all the Cylinder of the peece with oyle, that it may paſſe out the glibber: for when the fire hath rarified the water, it will burſt out ſuddenly. The experiment which we have in long Trunks ſhooting out pellats with aire onely, proveth this alſo.

CHAP. 52.

A Peece of Ordnance at one ſelfe ſame elevation, and towards one ſelfe ſame place, with the like quantity of powder and ſhot, diſcharged ſeverall times, what ranges it will make.

I Have diſcharged a peece ſeven times in the ſpace of 50 minutes, with the like weight of powder, ſhot, and elevation, and have found their ranges as following, the

the firſt ſhot was conveyed 416 paces, the ſecond 436, the third 440, the fourth 432, the fifth 425, the ſixth 410, the ſeventh 394, ſo that the greateſt difference from the firſt ſhot, was 24 paces, theſe things muſt be kept in perfect memory, by every one that learneth to ſhoot at randon, or he ſhall be never good at that practice. The reaſon of theſe things is this, at the firſt ſhot the bullet found the aire quiet, and at the ſecond ſhoot, it did not onely finde the aire ſtirred with the firſt ſhoot, but alſo moving or tending towards the place at which it ſhot, and becauſe it is more eaſie to move and penetrate that which is already moved and open, then that which is cloſe and quiet, it followeth that the ſecond ſhot finding in his range a leſſe reſiſtance then the firſt did, will outfly the firſt.

A ſecond reaſon is at the firſt ſhot the pouder being put in the peece, doth often times finde the ſame ſomwhat moyſt, eſpecially when it hath not been ſhot in for certain dayes before, through which the pouder will not fire quickly, as it doth when the peece is dry and temperately warme, for this warmth or heat will ſomwhat dry up the

the moyſture which is in the powder, and cauſe it to fire ſooner; wherefore the powder doth not worke ſo forcibly in the firſt ſhoot as it doth in the ſecond, the third ſhoot and fourth will be much like the ſecond, now I will give you the reaſon, why as the peece grows hotter, one ſhot wil not out-shoot the laſt, before it, but every time come shorter and shorter.

The peece waxing hotter, and by how much the more hotter, by ſo much the more attractive is the concavity of the peece made, and becauſe the shot is driven forth, or expelled with no other thing then by the airy exhalation, or winde cauſed through the *Salt peeter*, therefore by making ſuch a peece the more attractive with the more heate, which ſuppeth and reteineth continually more and more of that winde, which should ſerve to expell the bullet, the vertue expulſive in that peece, doth continually more and more decreaſe, and the shot flyeth not with that ſwiftneſſe as it did before; although the two firſt things, that is, the breaking of the aire, and the drying of the powder every time more and more, doth help much the range of the shot, which aide and help, as it

is to be beleeved, that ſomtimes it ſupplyeth and perchance gives advantage by that expulſive vertue, which continually the peece doth diminish, or ſup in according as it heateth, ſo that the third and fourth shoots will not be much differing from the ſecond shoot, nevertheleſſe in continuance of time, the ſaid two accidents (that is the opening of the aire and drying the powder by the heat of the peece) cannot ſupply the third accident, that is, the vertue attractive, by reaſon the attraction is augmented as the peece heateth. This cauſed my ſixth and ſeventh shoots to couvey the bullet 22 paces shorter then my firſt It is reported by *Nicholas Tartaglia*, that many shoots being made at a battery by a peece, it chanced by ſome occaſion, that the peece roſe up in ſuch ſort that the mouth touched the ground, a little dog paſſing by, did ſmell unto the peeces mouth, and by ſo doing was faſt joyned to the peeces mouth, and immediately after drawn into the ſaid peece: which thing, when the ſtanders by had ſeen, ſome of them ran to helpe the ſaid dog, and although they found him to be drawn almoſt to the further end of the concavity, they pulled him out al-

almoſt dead: This was done by the vertue attractive.

CHAP. 53.

How many Horſes, Oxen or Men will ſerve to draw any Peece of Artillery.

FOr every hundred weight of mettall, one man: ſo a Peece of 8000 pound weight, requires 80 men: beſides ſo many more men as the Carriage may weigh ſeverall hundreds: for every 500 of mettall uſe one horſe, then 16 horſes will draw a Gun of 8000 weight, but in the Winter 24, alſo 17 yoke of Oxen, is thought ſufficient to draw a Peece of 8000 weight, but in the Winter they need to be one third part more.

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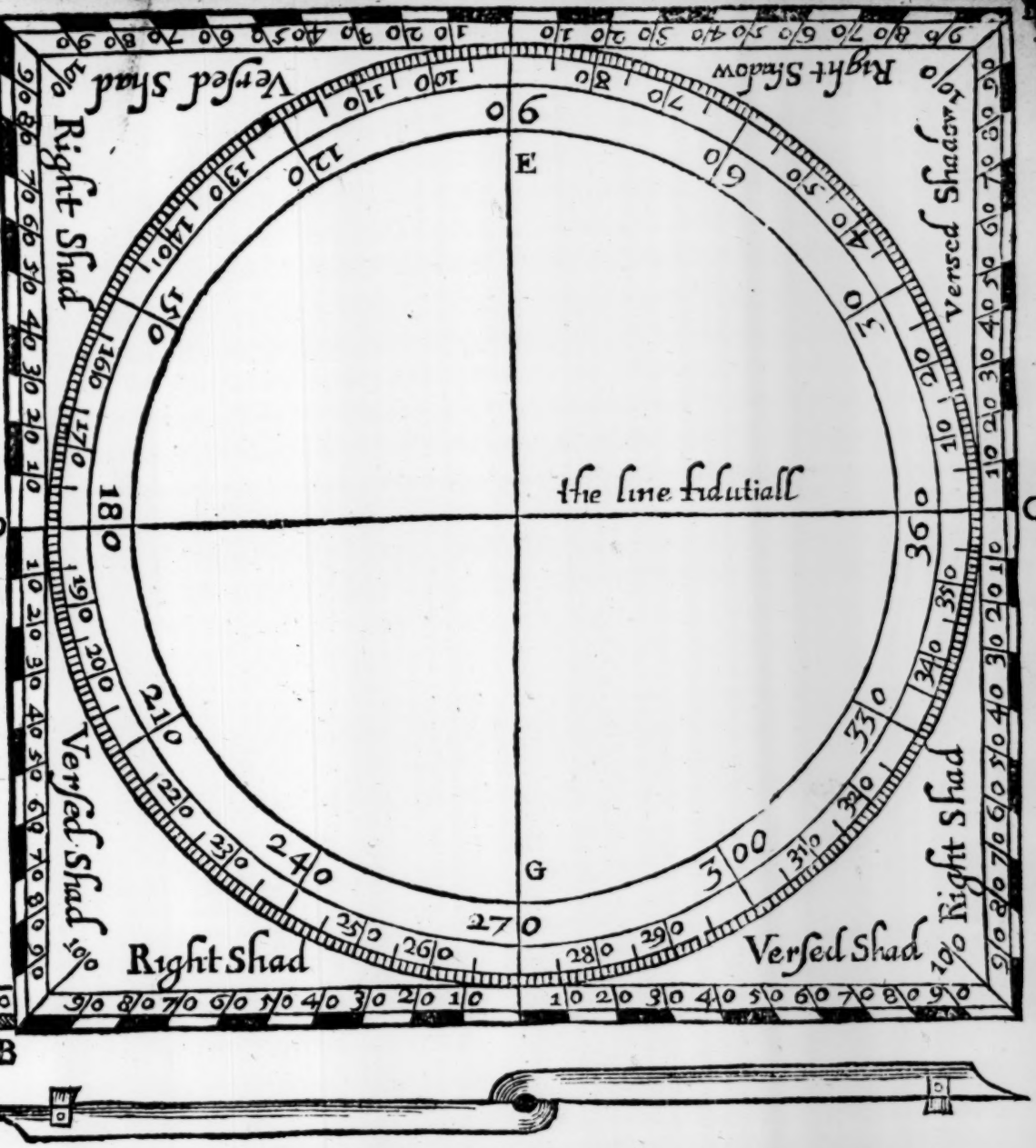
Chhp. 54.

A deſcription of the Inſtrument, wherewith the Reader muſt learn to take heights, depths, and diſtances.

THis Inſtrument is four ſquare, with a Circle in the middle, divided into 360 degrees : the diviſions on the ſquares, proceed from one; to ten; or from 10, to 100, the figure you may ſee before you; you may call this Inſtrument a *Circumferenter*, or *Geometricall Square*.

Sometimes you muſt uſe an *Index*, and at other times a Line, and Plummet, according as I ſhall (in the enſuing Treatiſe) give directions.

Chap.



Place the Inſtrument between 36 and 37, little c.

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Chap. 55.

The uſe of this Inſtrument, to finde the height of a Towre or Caſtle which is acceſsible.

FIrſt, holding one ſide of your Square Parallel to the Horizon, move the Index upward, till thorow the ſights thereof, you perceive the top of the Towre, or Caſtle; then look what part is cut by the Index, upon the Square, if it be of Right Shadow, multiply the diſtance to the baſe or foot of the Towre by 100, and divide by the parts cut, adding thereunto the height of your eye from the ground, but if of contrary or verſed ſhadow, multiply the diſtance from the middle of your foot by the parts cut, and divide by 100, not forgetting as well as before, to add the height of your eye from the ground.

If you finde it more covenienter to uſe the plumb line then the Index, doe thus, fix the line upon the pin on which the Index did

did move, and make your obſervation through the ſights on the ſide of your Inſtrument, marked with the letters A B, to the object you deſire to know the aforeſaid by, and the plummet line will cut the ſame diviſion as the Index did formerly.

Suppoſe the Index or plumb-line cut the 35th. diviſion of the Scale of verſed ſhadow, in making my obſervation towards the Caſtle or Tower, and the diſtance thereunto be 135 yards, what will the heighth amount unto: becauſe it is of Contrary or verſed ſhadow, then as you are taught before, multiply the diſtance from the middle of your legs to the baſe 135, by the parts cut 15, divide by 190, and the heighth will be found to amount to 75 yards and one quarter, above your eye, whoſe heighth as it ſhall be found muſt be added to the aforeſaid number.

CHAP.

Chap. 56.

How to finde the height of any Towre that is inacceſsible.

IF you would take the Altitude of any Towre, Wall, Hill, or other Edifice which is unapproachable, either in regard of the enemy lying between, or of ſome Ditch, River, or other impediment, you ſhall proceed as followeth: firſt approach to the neereſt and moſt convenient place for your purpoſe, where with your Inſtrument make obſervation; and note down, or remember what parts are cut in the Scale, you muſt then goe back in a ſtrait line, according to the commodiouſneſſe of the place, and make a ſecond obſervation, noting as before, the parts cut in the Square, which will be either on the Right or Verſed Shadow, if they fall both on the Verſed Shadow, (which moſt often doth happen) you ſhall divide the ſide of the Square ſeverally by the parts cut; and ſubſtract the leſſer

Quotient from the greater, and by the remainder, divide the distance between the two stations, to that adde the height of your eye from the Horizon, you have your desire.

Example.

Suppose the parts cut at the first station be 45 (Versed Shadow) and at the second 30, (both Versed Shadow) I divide the whole side of the Square, which is 100, by these two Sums severally, and finde the one to be conteined $2\frac{10}{45}$ *or in decimall parts thus,* $2|\underline{222}$ *) the latter number is contained* $3\frac{1}{3}$ *or* $3|\underline{333}$*, by the difference I divide the distance of the stations, substract* $2|\underline{222}$ *out of* $3|\underline{333}$*, the difference will be* $1|\underline{111}$*, the Distance 24 yards, being thereby divided, the product will be* $21|\underline{15}$*, the height of mine eye 5 foot, these added will give the height, 22 yards, 2 foot, and 2 inches almost, of the said object.*

CHAP.

CHAH. 57.

How to performe the ſame operation when the parts cut fall on the Right Shadow.

WHen the parts cut in each ſtation be of Right Shadow (which is very ſeldome) ſubſtract the leſſer number of thoſe from the greater, and put that in the firſt place: in *The Golden Rule*, or *Rule of Three*, the ſide of the Square in the ſecond place, and the ſtationary diſtance in the third.

Example.

Let the parts cut in the firſt ſtation be 30, in the ſecond 40, of right ſhadow, ſubſtract the leſſer from the greater, the remainder is 10, the which ſhall be put in the firſt place of the golden Rule, the ſide of the Square being 100, in the ſecond, and the diſtance between the

the two ſtations ſeven, in the third place, ſo the Rule ſtandeth thus: As the difference of parts cut, is to the whole ſide, ſo is the difference of ſtations, to the height required, Or, as 10 to 100, ſo 7 to 70 the height.

CHAP. 58.

How to take an Altitude at a place unapproachable, when the parts cut are of different Shadows.

IF the parts cut in the neereſt ſtation be of Right Shadow, and the furtheſt be of Contrary Shadow, they ſhall be both reduced to one Shadow, after this manner, ſquare the whole ſide which is 100, and divide the product by the parts cut of the verſed Shadow, and the Quotient will give the right Shadow: that being done, ſubſtract the leſſer ſhadow from the greater, and the remainer will be the firſt place in the Rule of Three, the diſtance between the two ſtations ſhall be the ſecond, and the ſide of the Square the third.

Ex-

Example.

Let the parts of Right and Verſed Shadow be both 30, *I deſire to bring them to be both Right: Firſt, I ſquare the whole ſide which here is* 100, *it maketh* 10000, *that Product I divide by the parts cut of Verſed Shadow, which is* 30, *the Quotient is* 333, *and one third part; from whence ſubſtract* 30 *the right ſhadow, out of* 333 *and one third, the remainder is* 303 *and one third, for my firſt Terme, the diſtance between my two ſtations* 13, *for the ſecond, and the ſide of the Square* 100. *for the third, The Rule ſtandeth thus, As* 303 *and one third, is to* 13, *ſo* 100 *is to* 4 *yards and* 18 *Inches.*

To take the height of a Towre or Caſtle ſtanding on a hill.

To performe this, you muſt firſt take the height of the hill at two ſtations, as of a thing unacceſſible, and after the ſame manner, take the height of the Hill and Towre together, which being done, ſubſtract the height

height of the ſaid Hill from the whole, the remainder will be the height of the Towre.

CHAP. 59.

How to finde the Longitude or Diſtance to any place by the Square.

I Deſire to know the Diſtance to a Towre in the wall of a City, becauſe of placing my Ordnance to diſmount a Gun upon the ſame, I make choyce of a convenient place for my ſtation, where placing mine Inſtrument, I bring the Index to the point C, to lye juſt upon the line D C, written in the figure, *The Line Fiduciall*, becauſe from this line proceeds the beginning of the Degrees in the Circle, and it is moſt uſed, the Index being on this Line, move the Inſtrument till you perceive through the Sights the Towre: letting the Inſtrument reſt firme, turn the Index directly upon the other line marked with E G: looke through the Sights, and if you can eſpie any place or thing, that you can re-

nember to finde exactly, take that for ur ſecond ſtation, if you canuot eſpy erewithall to remember, cauſe one to go vards ſuch a place, that you can ſee ough the Sights, with a handkirchief in hand, when you eſpy that, bid him drop pon the ground, and goe to that place, ere ſet up your Inſtrumeut, and laying ruler upon *The Fiduciall Line*, turn the rument untill you can eſpy through the hts your firſt ſtation, then letting the In- ment ſtand firme, turn the Index untill can likewiſe eſpy the Towre through Sights, and marke diligently what part its in the Square, then: As the parts cut to 100 (the Radix) ſo the diſtance be- en the two ſtatious, is as the Diſtance ired.

Example.

uppoſe the parts cut were 5, the diſtance veen the two ſtations 30 paces, then as 5 is 00, ſo is 30 to 600 paces, the true diſtance e Towre.

CHAP.

height of the ſaid Hill from the whole, t
remainder will be the height of the Tow

Chap. 59.

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Example.

Suppoſe the parts cut were 5, the diſtance between the two ſtations 30 paces, then as 5 is to 100, ſo is 30 to 600 paces, the true diſtance to the Towre.

CHAP.

Chap. 60.

How to take the diſtance of divers places at one time, by help of the Circle that is deſcribed within the Inſtrument.

FIrſt of all, finde ſome convenient place in which ſet up your Inſtrument for your firſt ſtation, and laying the Index upon the fiduciall line, turne the Inſtrument with the Index upon the aforeſaid line, untill you ſee ſuch a place as you thinke moſt convenient, (for in this you may chooſe your ſecond ſtation, which by the practice in the laſt *Chapter* you could not doe,) The Inſtrument thus fixed, eſpie through the holes, every one of thoſe places whoſe diſtance you would know, and write them down, I mean the degrees cut in the Circle, with the name of the place, alwayes remembring to begin ſo far on the left hand, as you have any marke that way; when you have noted them all down according as I have

have taught, goe to the ſecond ſtation, and place your Inſtrument there, lay the Index upon the fiduciall line, and looke back to the firſt ſtation, and eſpie it through the holes, after this, be ſure your Inſtrument be not ſtirred, then turn the Index to the firſt marke you tooke at the firſt ſtation, and after obſervation made, note it down, as at the firſt time, when you have obſerved all the marks: take your Inſtrument away, goe to a large Table, and with your Ruler draw a ſtrait line, acroſſe the Table, parallel to the Tables end, and about two foot one from another, deſcribe two Circles, the former made line being a diameter to each Circle. Firſt, divide the diſtance between the centers of the two Circles into ſo many equall parts, as there were paces betwen your two ſtations, then divide the Circles. In each center fix a needle, and tie to each needle ſo many ſilke thrids as you had marks, extend each of theſe at a great length, juſt cutting the degree in the Circle, that was cut in the Circle of the Inſtrument, when you made your Inſtrumentall obſervation, beginning firſt with the firſt marke, ſo proceed, and the end of every thrid which

muſt

muſt be very long, faſten to the Table with a little ſoft wax, when you have faſtened all the thrids thus, that are on the firſt needle, which ſignifieth the firſt ſtation, place thoſe on the ſecond needle as you did the other, with wax at their full extent, juſt over the Degree in the Circle, made on the Table, as you have noted was made upon your Inſtrument by obſervatiou, beginning with the firſt as you did before, and ſo likewiſe faſten them. Now to know the diſtance to theſe marks, looke where the firſt ſtring of one Circle croſſeth the firſt of the other, that place note for the firſt marke; looke where the ſecond croſſeth with the ſecond, that note for the ſecond marke; ſo likewiſe, for the third, fourth, &c. till you have noted all the marks down, then with a paire of Compaſſes meaſure the diſtance unto any marke in paces or yards, according as the Scale between the Circles is divided, and what diſtance you finde to be, either between one marke and another, or between the ſtations and the marks, is the true diſtance between thoſe marks, or between either of your ſtations and marks, in paces, yards, or feet, according to the diviſion of your

your Scale, but if the firſt, ſecond or third thrid, &c. in one Circle, doe not tend to the ſame marks that you have noted in the obſervation, as the firſt, ſecond, and third doth in the other Circle, then you are to make the marke where two thrids croſſe that doe tend to the ſame marks.

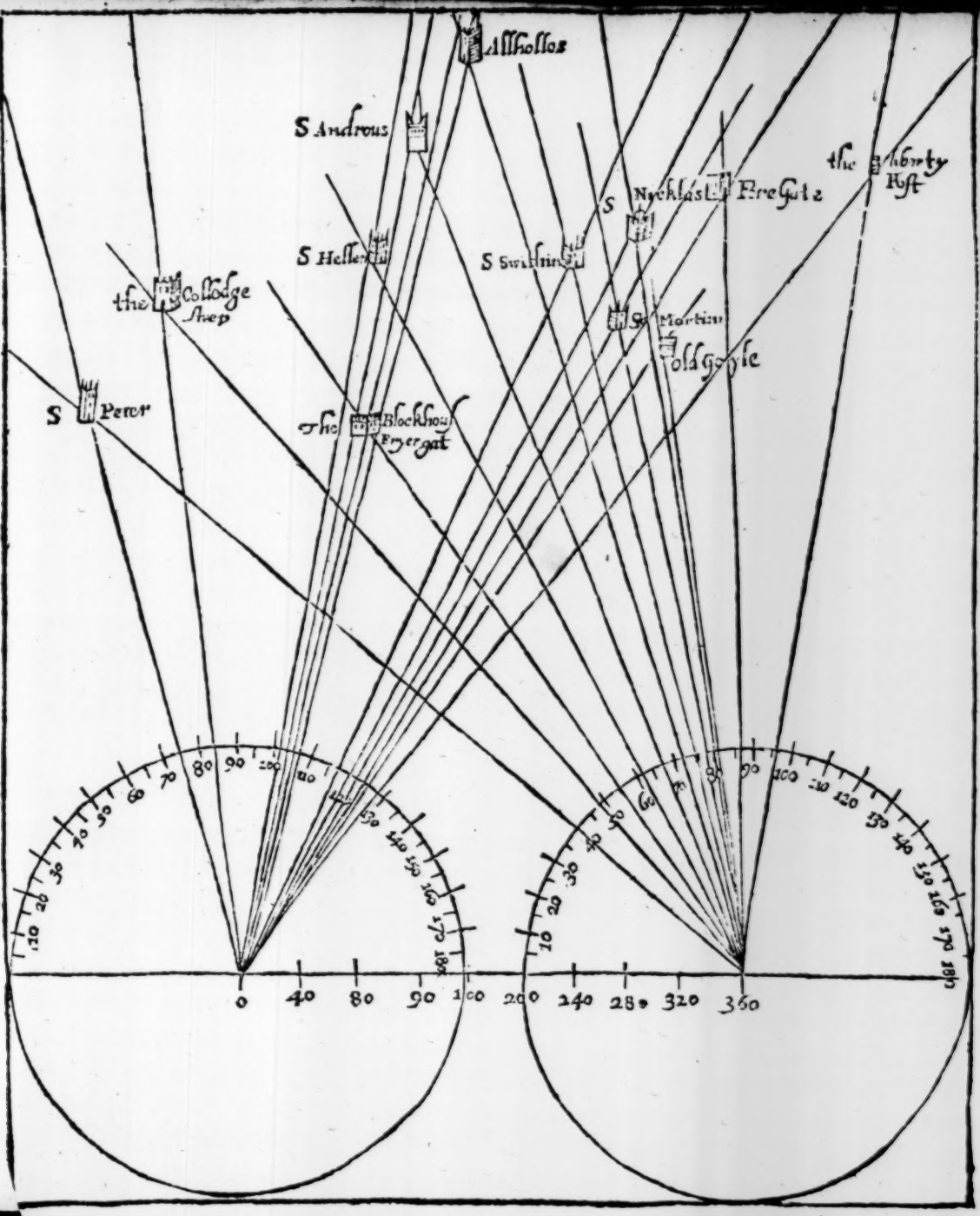
An Example to cleere and manifeſt the laſt Propoſition.

At ſuch time as the Leaguer was before the City of *Worceſter*, I tooke the diſtance by ſuch means as I have afore taught, to every remarkable place therein, by the aforeſaid Inſtrument.

Firſt, finding a convenient place for the firſt ſtation, and placing the Index upon the *Fiduciall line*, I marked where to make a ſecond ſtation: the Inſtrument ſtanding immoveable: The firſt and fartheſt marke towards the left, as I obſerved was Saint *Peters* Steeple, the Index cutting 75 *degrees*, the next obſervation was made at the Colledge Steeple, the Index cut 84 *degrees*, then Saint *Hellens*, the parts cut in that ob-

ſervation 102, my fourth marke was the lofty Spire of Saint *Andrews*, 104 *degrees*, the fifth marke was the new built Block-houſe, where formerly ſtood the Fryers gate, the *degrees* cut were 106, the ſixth obſervation was made towards the high Towre Steeple of *All Saints*, the Index cut 107 *degrees* in the Circle, the ſeventh object was the eighth ſquare Towre Steeple of Saint *Swithins*, 117, the eighth which was worth obſervation was the brick Steeple of Saint *Nicholas*, where the Index cut juſt 120 *degrees*, the ninth obſervation which I made was towards Saint *Martins* free-ſtone Steeple, where 122 *degrees* were cut, the tenth was made towards the Fore-gate, called of ſome the North gate, becauſe of its ſituation North, here the degrees were 124, then I placed my Index upon or towards a rotten Towre in the walls of the City, ignorantly called the old *Gaole*, upon which a gun was then placed, the degrees cut in this obſervation were 126, my twelfth and laſt obſervation was towards the liberty poſt ſtanding amongſt the deſolate ruines of Fore-gate ſtreet, where the Index cut in the Circle 128 *degrees*.

Ha-



Place the plot of WORCESTER, folio 50, little d.

Having noted down all the aforesaid, I went to the second station, placed my instrument right for observation (by looking through the sights of the Index, it lying upon the fiduciall line to the first station) I began as before to make my observations, first of all at those places which lay fartheſt on the left hand, and so proceeded orderly to the right. Saint *Peters* cut 40 *degrees*, the Colledge steeple 48, the Block-house 55, Saint *Hellens* 61, Saint *Andrews* 67, *All Saints* 72, Saint *Swithins* 75, Saint *Martins* 78, Saint *Nicholas* 80, the old Gaole 81, Fore-gate 86, and the liberty post 95 *degrees*.

The distance between the two stations is 360 paces: upon a Table board I made two Circles, and divided them into 360 parts, or *degrees*, or onely the upper halves into 180 *degrees*, I placed two needles in each center one, and upon each 12 thrids, first I extended the thrids in the Circles in the left hand, which signifieth the first station, just over such degrees which were cut at time of observation, proceeding orderly, the first thrid for Saint *Peters*, the second for the Colledge, the third for Saint *Hellens*, &c.

When you have placed all the thrids which are on the firſt Needle, doe the like with the thrids upon the ſecond Needle, beginning firſt towards the left hand with Saint *Peters*, next the Colledge, the third the Block-houſe, the fourth Saint *Helleus*, the fifth Saint *Andrews*, &c. all the thrids being placed, looke where the thrid of the ſame marke in both Inſtruments croſſe one another, juſt there make a prick for the marke: as for Example, the thrid of the Block-houſe is the fifth in th firſt Circle, and the third in the ſecond, where theſe two croſſe is the block-houſe, meaſure with the compaſſes according to the Scale, between the center of each Circle, and you ſhall finde the ſaid Block-houſe to be diſtant from the firſt ſtation 400 paces, from the ſecond 476 paces, from Saint *Peters* 197 paces, from Saint *Andrews* 203, from the Fore-gate 304, and from the liberty Poſt about 400.

The diſtance between *All Saints* Steeple and the firſt Station is 680 paces, between it and Saint *Andrews* it is 35, from Saint *Peters* 273, and from the Fore-gate 202.

Saint *Andrews* is diſtant from the firſt ſtation 610, from Saint *Martins* 192, from Saint

Saint *Swithins* 142, and from the Colledge 212: Thus you by the Scale and Compaſſes may finde the diſtance to and between any of them.

Chap. 61.

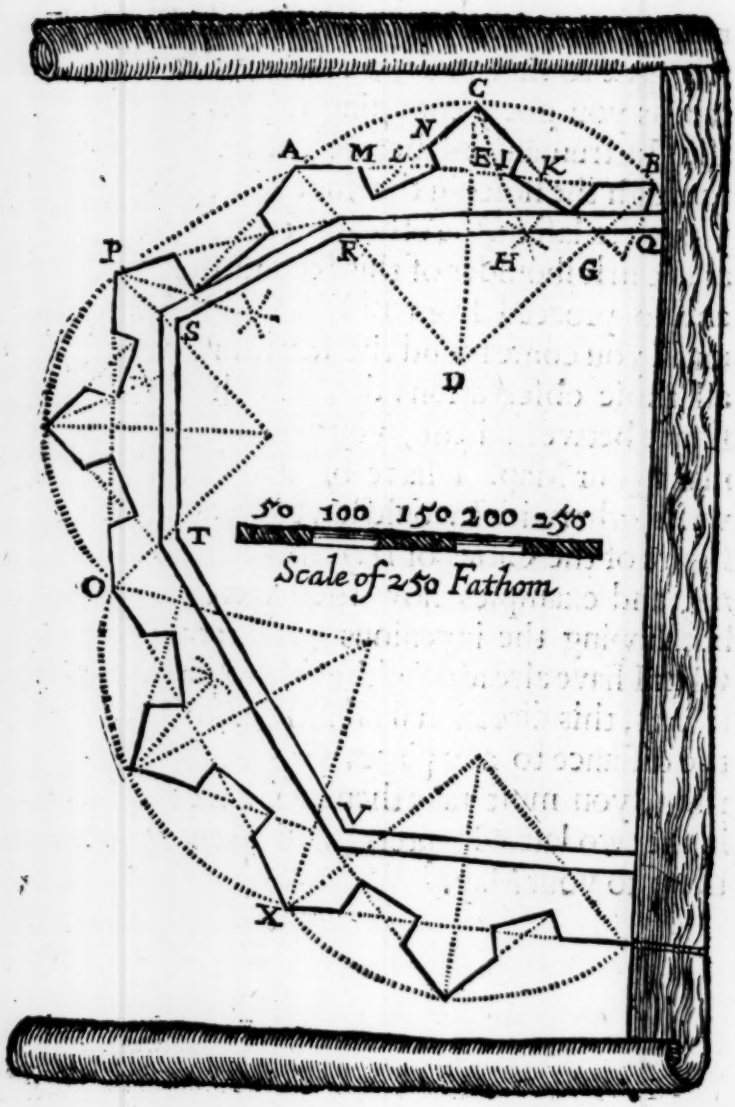
How by the aforeſaid Inſtrument, to draw the Plot of a City or other Garriſon, and to take the diſtance to every remarkable Object within Cannon ſhot.

IT behoveth every Maſter Gunner, of a Towne, Caſtle, or other Fort, to draw a deſcription of his ſaid Garriſon, and of every notable object within Cannon ſhot, for he having a Map of all theſe things, need not be troubled to take the diſtance every time he hath occaſion to ſhoot at the enemy, for by his Map and the objects without the Garriſon therein deſcribed, he may be able to eſtimate how far or neer the enemy doth reſide. To make a deſcription of the Gar-

riſon, he is to doe thus, ſet up his Inſtrument firſt upon the ſhoulder of the Bulwarke, and obſerve the angle thereof, by placing his Index firſt upon the *Fiduciall line*, and moving the Square untill you may perceive the Flanker, then letting the Inſtrument remain fixed, turne the Index till you can ſee the Diamond point through the holes, the Degree cut is the angle of that ſhoulder, with a chain or line, meaſure the diſtance to the point of the Bulwarke, and meaſure that Angle as you did the former, by eſpying through the Sights (the Ruler or Index lying upon the *Fiduciall line*) the place where you ſtood laſt on the ſhoulder, from the Diamond point meaſure the diſtance to the ſecond ſtation, and obſerve the angle of that as before is taught; firſt, by looking back through the ſights, the Index lying upon the *Fiduciall line* to the Diamond point, then turning the Index, looke to the angle at the flanke, note as before the degrees of the Angle: Then departing from that place, meaſure to the angle of the Flank, there alſo ſet up your Inſtrument, firſt looking through the ſights at the place you were laſt at, turn the Index and looke ſtraight along the Curtain,

to

to the angle where it joyneth with the Flank, then goe to that angle, measuring the Curtain as you goe, comming thither, set up the Instrument as before, first looking through the holes in the Index at the place you were last at, the other observation make at the first shoulder of this second Bulwark, and so proceed from Bulwark to Bulwark untill you come round the Garrison, noting all those observations down with the distance between them, you may be able to make your Map. I have but a short time to write, otherwise I would have given you the figure of the Cities of *Worcester* and *Coventry*, and examples how they were drawn, but hoping the ingenious practizer will by what I have already said, be able to doe these things, this direction shall suffice. To know the distance to any places without the Garrison, you must take them as I have taught in the two last Chapters, and then annex them to your Map.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A TREATISE OF Artificiall FIRE-WORKS for Warre and Recreation.

Conteining a deſcription to make ſundry kinds of FIRE-WORKS both for uſe and pleaſure, with leſſe labour and coſt then any hath heretofore been publiſhed.

All of them being experimented and practized by the Author: as alſo compared to the beſt, which are taught by any other Author whatſoever.

By *Nathanael Nye.*

London, Printed for *William Leak*, at the ſigne of the *Crown* in *Fleetſtreet*, 1647.

A TREATISE OF Artificiall FIRE-WORKS for the Wars.

CHAP. I.

A deſcription of the Morter-peece, and how to make one of Wood and Paſtbord for a need, thoſe of Braſſe and Iron being wanting.

THe beſt Morter-peeces are made of the ſame mettall that braſſe Ordnance are made of, and being to be made, let the meaſures following be obſerved,

ved. If the Diameter or bore be nine inches, let the morter be one foot and an halfe in length, and let the chamber in which you load your peece with powder be three inches diameter, and foure inches and a halfe deepe, the thickneſſe of the mettall about the touch-hole three inches, and the upper part thereof one inch and a quarter.

How to make the Morter-peece of Wood and Paſtbord.

You muſt get a woodden rouler of ſuch bigneſſe as you deſire to make the diameter of the Morter, and upon that rouler let paſtbords and canvaſs, with good ſtore of molten glue, be rouled (remembring to anoint the rouler with greaſe, or otherwiſe the glue will cauſe that you cannot take the paſtbords off again) which done, let the canvaſs and paſtbords dry a little while on the rouler, another while off from the rouler, and when this kinde of trunk is very dry, put it on the rowler, and ſet it in a lathe, and cut off both ends of the trunk with a Chiſell very

very even, taking this out of the lathe, turn a foot thereunto, with a ſhoulder to put the trunk upon, and in the middle thereof make the chamber for the powder, if the peece be eight inches in the mouth, let the thickneſſe of the paſtbord trunke be two inches thick, and 18 inches long, the britch or foot be 10, the ſhoulder two inches long and two inches high, that when the trunk is put on this ſhoulder, and joyned with the wood, it may be juſt even with the ſame, the bore into which you put your powder muſt be two inches high and three deepe, plated with copper or lattin, if it be poſſible, as alſo all the face of the wood that goeth into the trunk, when you have put the trunk upon the britch of wood, naile it round about the ſhoulder, firſt making holes with a bodkin through the paſtbords, and then driving in the nails upon that wood which you made to receive the paſtbords or trunks on, being cut lower then the reſt by two inches, the thickneſſe of the trunk, becauſe when it was put on, it might be levell with the reſt of the britch, theſe things done, cover both wood and trunke with cord and glue again, which being well dryed will laſt

a long time, I have ſuch a one of this making, wherewith I uſe to ſhoot *Ballouns* into the aire, for my recreation.

There is a very honeſt man in the Market Town of Bromſgrove, *named* John Tilt, *who can make either Morter-peeces or Ordnance, with Tin, Wire, Paſtbord, and glue, of excellent durance and ſervice, if not wronged in the charge or loading of them.*

Chap. 2.

How to fit and prepare Granadoes for the Morter-peece.

MOſt commonly the ſhot for great Morter-peeces are one tenth part lower then the bore, becauſe of cording them to ſling into the mouth of the peece, and for feare of ſecret cracks, that cannot eaſily be eſpyed, they are coated with pitch, ſo that being prepared, they doe but juſt fit the bore.

How

How to make Fuſes.

Every Ball hath a hole, left to put in a fuſe or piece of wood juſt like a Faucet for ſpigot, this hole muſt be one quarter the diameter of the woodden Fuſe, which Fuſe muſt be in length three quarters the height of the Granade, made taper, and when filled with compoſition driven gently in amongſt the powder that is in the ball, leaving a little of it without: the compoſition for this fuſe is made thus: take one pound of Powder, foure ounces of Salt-peeter, and one of brimſtone, firſt beaten to powder, and ſifted in a ſerce ſeverally; theſe ingredients being mixed together, your compoſition is made fit for uſe.

Chap. 3.

The manner how to make Granadoes of Canvas for the Morter.

THe operation of theſe Granades made of canvas, is quite contrary to thoſe already ſet down, theſe are onely

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THe operation of theſe Granades made of canvas, is quite contrary to thoſe already ſet down, theſe are onely

onely fit to fire a Town, they are not of ſo violent execution as the precedent yet altogether as coſtly in the making; for the making of them fill a piece of canvaſs upon a round ball of wood, ſo big as you would have your *Granadoe*. Then make this compoſition following, four pound of Salt-peeter, two pound of Gun-powder duſt, and two pound of Brimſtone: all theſe incorporated and moyſtned with oile of Salt-peeter, fill your caſe with this compound, and cover it with cords, which done pierce the ſack full of holes with a good bodkin, and in every hole place a little iron barrell, charged like a Piſtoll: theſe muſt be driven into the ſack up to the head, the *Granadoe* being thus prepared, let there be made a hole about one inch deep, which ſhall ſerve to prime it with powder-duſt, moyſtened with oyle of Petroll; you may make all thoſe barrels of old musket barrels, or of other pieces either little or bigger, onely leave wide touch-holes, to the end the ruſt ſtop them not, ſo they may be preſerved many years; and ready for ſervice at all occaſions.

CHAP.

Chap. 4:

How to make fiery Arrows or Darts.

GEt a long ſhaft of wood; and joyne unto it an iron head; after the manner of the figure, in the margent; and about the middle of that head make firſt a linnen bag, in form of an Egg, leaving open

at the end before a hole, that it may be fitted with the compoſition following. Take one pound of Petor, half a pound of Gun-powder, and as much Brimſtone in powder; all theſe ingredients being well mixed, and mingled with oile of Petrioll: with theſe fill the bag round about the arrow head: then let all be bound about with wire, and for the priming of theſe, dip Cotton-weeke into Gun-powder wet with water, let the Cotton be well dryed again before it be applyed. Now for the joyning of your wooden ſhaft to the arrow head, it ought to be done ſo ſlightly; that being faſtned into any thing, thoſe may be deceived, and pull it onely away, & to hinder that one may not pluck out the head with their hands; there may be made a ſmall hole quite thorow backwards, and ſo a man will be prevented in aſſaying to pull it off; although it ſtick in his fellows clothes.

CHAP.

Chap. 5.

How Granadoes are to be charged in the Morter.

THere ought to be great care taken in the loading or charging of the Morter, which muſt be done thus; Firſt, wey the powder to a dram, that you put in the Chamber, and after it put a good cloſe wad of hey (for to my knowledge and deep experience it is very uncertain ſhooting, you uſing in ſtead of hey, a tampion of wood) which done cut up a turff of the ground, that may fill the bottom of the bole, or bore, of the Morter, next the wad: your *Granadoe* being prepared, as is before taught, with a coat of pitch and chord, ſling it into the mouth of the Morter, obſerving to have the Fuſe of the *Granadoe* in the middle of the bore: then go to the britch, thruſt up a wire into the touch-hole, to make all ſure, then prime with ſpeciall dry powder, ſuch as you

are ſure will take fire, this being the whole buſineſſe in which your life and Motter-peece both ſtand in jeopardy: I will give you very ſure directions to give fire.

Provide ſmall Fuſes, ſuch as I taught you to make before for the ſhels, but a great deal leſſe, about one quarter of an inch bore, three quarters in thickneſſe, and eight inches long: fill theſe with good pouder duſt, moyſtned with oyle of *Salt-peeter*, you muſt moyſten it but a little, and put it in with an iron rammer, try whether you like the time they continue burning, if too ſlow, abate oyle of *Peeter*, if otherwiſe, adde it thereunto.

Theſe being made ready, the uſe of them is thus: thruſt the pike of your Linſtock in at one end of the Fuſe you mean to give fire withall, bid one of your aſſiſtants come on one ſide of the mouth of the peece, and give fire to your fuſe, wherewith fire the Fuſe in the Morter, and then with great ſpeed give fire to the touch-hole.

Theſe Fuſes are very certain to give fire, but Match doth oft times faile.

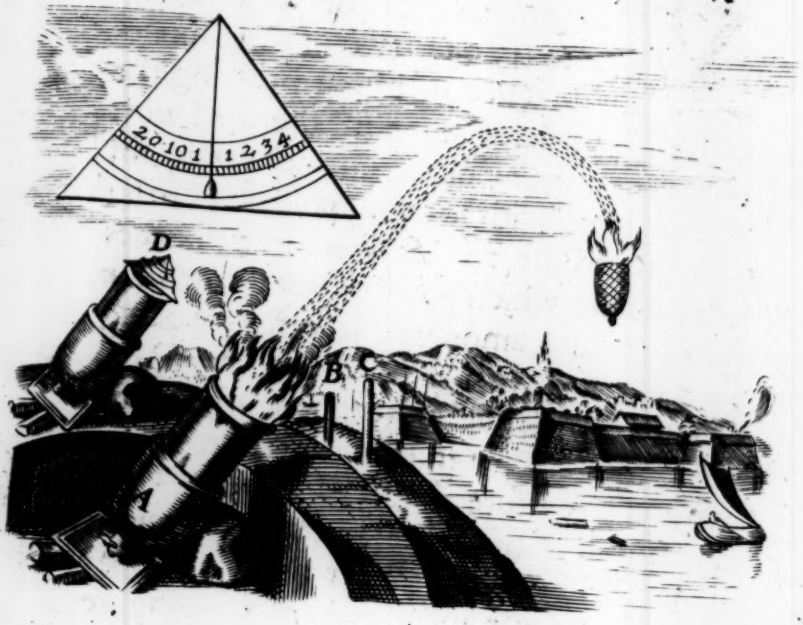
CHAP.

Chap. 6.

How to levell the Morter-peece, to make an effectuall ſhot at any aſſigned mark.

YOu are to get leave of your Superiours to try one, two or three ſhoots for practice, without breaking the ſhell; if you have leave fill the ſhell with powder, and put it out again, and wey it: fill the ſame ſhell with ſo many pound of earth: then take a Fuſe, and at the end tye 3 ounces of powder; which put down with the Fuſe into the hole amongſt the earth; making ſuch way firſt with the end of ſome ſtaffe, that the powder be not torn from the Fuſe; this being thus put in, take the ſquare where with you meaſure diſtances, place it upon the mouth of the peece, if it be big enough, if not help it with a longer Ruler, let that ſide of the Inſtrument marked in its figure with A K, lye either upon the brim of the

Peece, if it will reach if not upon the rule, take off the Index and hang on the plunmet, ever obſerving to mount your Peece above 45 degrees, then elevate the Peece at what randon you pleaſe, noting it downe; then make your ſhot, getting thoſe that ſtand by to go and obſerve whether the Fuſe burn all the while of the *Granadoes* flight; and when the three ounces of powder take fire: for hereby you may mend the Fuſe, and try



whether it will keep fire, theſe things obſerved, meaſure that diſtance, and place it in your note, under the degree you mounted by, as alſo the weight in powder the Morter uſed. When you by two or three ſhoots, have gathered experience, both of your fuſe, and of the true range of your Peece: take the diſtance to the Town, Fort, or other mark, you are to ſhoot at; then to know at what degree to mount the Morter-peece do thus, by the *Rule of Proportion Reverſe*, as the diſtance (when you made your tryall) is to the degrees cut, ſo the diſtance to your aſſigned mark, is to ſuch a degree of the Circle that you muſt mount your Peece unto: To make more eaſie, I will give you an *Example*.

Suppoſe, that you made your experimentall ſhot at 46 degrees, and your ball ranged 320 paces, how many more degrees muſt you mount the Morter to ſhoot 280 paces: that being the diſtance to your aſſigned mark: multiply 320 by 46, and there ariſeth 14720, which divide by 280, you ſhall have 52 degrees, and above half one, to which you muſt mount, to reach the appointed place.

Note, That if you are to play a Morter-peece along time againſt a Fort, you are to ceaze upon a barrell of the beſt powder in the Magazine, and keep it for your uſe; alſo go into ſome place free from fire and ſtir this powder, that in caſe one end be weaker then the other, you may mend that defect: for I do aſſure you, that if you change your powder, you have loſt all your experience, and are as new to begin again, as at the firſt time: alſo beware of uſing tampions, let one man conſtantly put in the wad, giving him charge to make the like wad, and uſe the ſame ſtrength, ſo neer as hee can, which hee did before; waſh every one of your ſhels before you coat or put the chord upon them, when you have made them clean, put a little powder into one of them, and give fire to it with a match, then ſuddenly clap a clot of clay upon the hole; then obſerve diligently whether any ſmoke come out on the ſides, if it do then that muſt be very carefully coated, or not uſed, but thoſe that vent no ſmoke: you may truſt to be good ones.

Another obſervation I will tell you of, that is, you muſt by the helpe of a great paire of Scales wey every ſhot, and make them

them all even of a weight, by putting there into ſo many Muſquet bullets as will make them even, this being done, fill that which is heavieſt, (for without doubt that will contein leaſt powder) put the powder out again, and wey that powder; ſuch a quantity, and no more, fill all your *Granadoes* withall.

Chap. 7.

How to make Granadoes to caſt with mens hands.

HAving taught how to make *Granadoes* for the Morter-peece, and that in an eaſier and plainer way then any ever before me hath done to my knowledg: I will ſhew how to prepare ſome ſmall *Granadoes* for the hand, the effects whereof are no leſſe eſteem then the other, chiefly in aſſaults; whether it be for the offendants or defendants; Firſt of all fill theſe ſmall ſhels with fine Gunpowder, then make a Fuſe of one

one ponnd of Gunpowder, ſix ounces of Salt-peeter, and one of Charcole, or if you would have them of leſſe durance, you may take of the compoſition made for the Fuſes of great *Granadoes*, knock the Fuſe up to the head within one quarter of an inch: which is onely to finde it by in the night, ſtop well the reſt of the hole in the *Granadoe*, (if any chinks are open) with ſoft wax: then coat

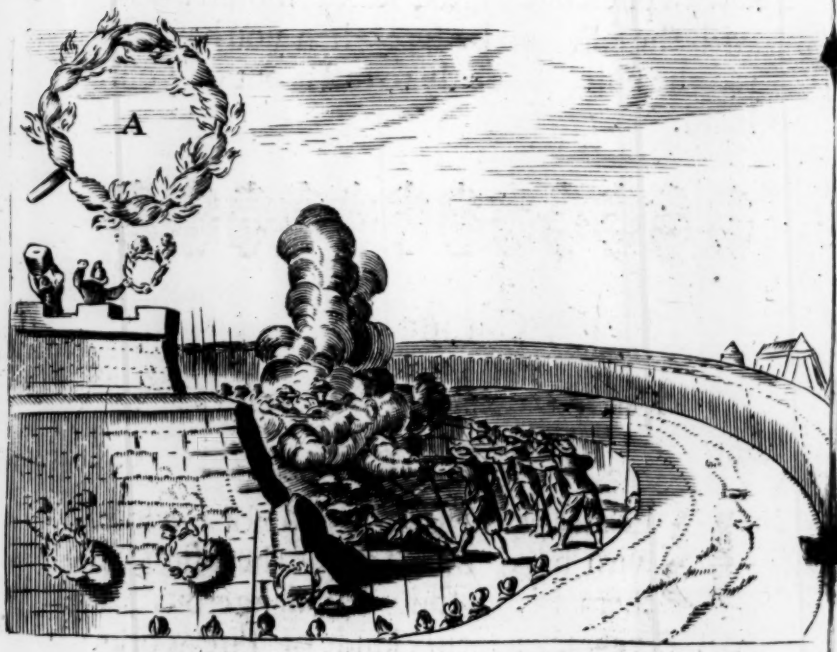
it

it with pitch and hurds, leaſt it ſhould break with the fall, and be ſure when you have fired the Fuſe, ſuddenly to caſt it out of your hand.

Chap. 8.

How to make fiery Wheels, to be caſt with mens hands.

BEcauſe every ſouldier wil not meddle with hand *Granadoes*, the uſing of them being ſomwhat dangerous, I will here teach another kinde of Fire-works which is little leſſe offenſive, for the making thereof, you are to uſe theſe ingredients: Take four pound of Gunpowder in duſt, one pound of Charcole duſt, two pound of Tar, two of Salt-peeter, and one pound of Roſin; all theſe ingredients being well incorporated, and heat over the fire, ſteep tow or flax in the ſame, and then wrap the tow, and flax about a hoop, and then cover all this again with Gunpowder duſt; and in time of need

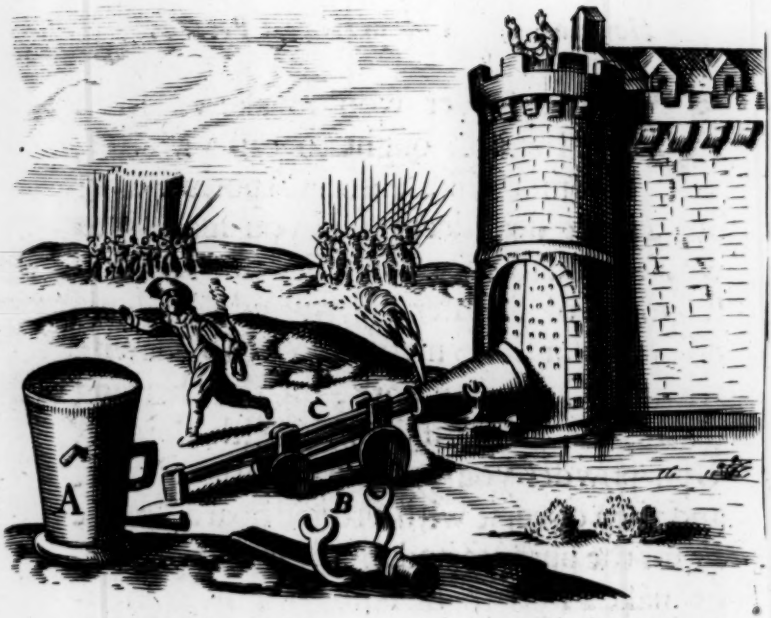


need give fire to them, & caſt them amongſt your enemies, this is to be obſerved, that the hoops ought not to be too large, but falling upon a many ſouldiers they may there ſtay and ſtick, and to make them more troubleſome, and entangling, two of them may be tyed a-croſſe one another; and then falling upon any man he cannot chooſe but be much aſtoniſhed, with ſuch a fearfull element, and put his company in great diſorder.

CHAP.

Chap. 9.
How to make and prepare a Petard.

WHoſoever would make exactly a Petard, ought to caſt a Morter, much like unto an Apothecaries; but a great deal deeper, if you make it to wey 36 pound, the concavity muſt contein ſix pound of powder, if you add or diminiſh more or leſſe mettall, doe ſo likewiſe with the Calliber or bore, for the charging of this Petard, fill it onely with the beſt Gun-powder you can, to the brim almoſt, and then cover it with a round board, made fit for the purpoſe, and for the priming thereof make a Potfire, or Fuſe, of ſlow compoſition, of what length you pleaſe, this muſt be put down a hole in the middle of the cover of wood, a good way into the powder, if the Peece have no touch-hole, and cloſe waxed about that no ſparke of fire ſhould get in, and the Petard is prepared, to breake open the place you deſire if it be acceſſible, then with the breech of the Petard, upon the ground, or ſome great ſtone, or piece of



of wood, and the mouth againſt the part of the door, or gate, but if the place be unacceſſible, then make a little Cart with two, or four wheels, and ſo ſupport the recoyle of the Petard, ſhooting off: The Petard muſt be made faſt to a long beams end, that muſt go a-croſſe the ditch or moat, the reſt of the beam and heavieſt part thereof reſting upon the Wheels, able to counterpoyſe the other part

part thereof, together with the Petard: and it is prepared for to make a breach in a ſlender wall, or door, or gate, unacceſſible.

Chap. 10.

Of Artificiall Fire-works for Recreation and delight.

How to make Rockets for the Aire.

I Will not teach how to make Moulds, Needles, &c. for ſuch men as are curious in theſe things, let them buy Maſter *Bate*, Maſter *Babington*, or for a need Maſter *Malthus* Fire-works: that which I will onely do ſhall be to teach to make them without Moulds, or any other thing then a rouler to roule the paper upon: for ſuch I uſe to make, having all other deviſes that are taught by the aforeſaid learned men, but make little uſe of them; to make Rockets my way do thus, cauſe a Rowler to be turned in a lathe, what thickneſſe you pleaſe: onely let the rouler be 8 times the diameter therof in length, if it be three

three quarters of an inch in thickneſſe, the length will be three inches, roule your paper hard on the rouler; till it make an inch and one quarter the whole thickneſſe rouler and all, then glue the uppermoſt paper, and the caſe is made, onely choaking or contracting the paper together, (within one diameter of the bore of the end) except one little hole, about one quarter the Diameter of the bore thereof: to contract theſe caſes on this manner, doe thus, wet the end about one inch in water, then put the rouler in again, and tye a great packthrid about the wet, within three quarters of an inch of the end, put another thing almoſt of the ſame diameter of the rouler in at the wet end about halfe an inch, hold it there, get ſome other body to draw the packthrid together, you holding the rouler and rammer, one put downe to the end within one inch, and the rammer which muſt be a little leſſe in diameter, to meet with that end within halfe an inch, in which place the contract or choaking muſt be; the packthrid having drawn it together, tye it faſt on that place, take out the former, let it dry and it is done: when the hole is contracted together, make it ſo wide, as is

before

before taught, with a round Bodkin, which you muſt provide for that purpoſe.

A The mouth of the Rocket. B ſo far muſt the Bodkin be thruſt up the middle. You muſt have a ſmaller Bodkin (which when your Rockets are filled with compoſition, and tyed to the rod) you muſt thruſt this Bodkin in at the mouth, ſtraight up to the midſt of the Rocket, having a care of thruſting it neerer one ſide then the other.

Chap. II.

How to make the Compoſition for Rockets of any Size.

THeſe wayes which I will teach you, I take them not upon truſt out of Authors to that purpoſe, but have experimented what I teach, and firſt for Rockets of one ounce, you muſt uſe onely Cannon-powder duſt, being beaten in a morter and finely ſearſed, which riſeth very ſwift, making a great noyſe, but carries no taile: thoſe of moſt beauty in their operation are made, with putting one ounce of charcole duſt, to eight ounces of powder, this compoſition will hold for Rockets of one, two, and three ounces; but for thoſe of foure, take three ounces of charcole to one pound of Cannon-powder duſt, continuing that rule, untill you come to Rockets of ten ounces, and from thence to Rockets of a pound, one pound powder duſt, and foure ounces

ounces of charcole duſt: bigger then theſe I have no experience of.

To fill the Rockets with this compoſition.

Place the mouth downwards where it was choaked, and with a knife put in ſo much as you can of the receits, provided for that ſize at one time, then put down your rammer, which muſt be longer and narrower then the former or Rouler upon which you made the caſes, and with a hammer of a pound weight, give three or foure indifferent knocks, then put in more compoſition with your knife, untill it be full, at every time knocking the like as before, with the rammer, untill the compoſition come within one diameter of the bore of the top, there put down a peece of paſtbord, and knock it in hard, prick three or foure little holes therein, then put fine piſtoll powder in almoſt to the top, and upon that another cap of paper, upon which put a peece of leather, that it may be tyed on the top of the Rocket, and faſt glued on, then get a ſtreight twigge, and binde it upon the Rocket with ſtrong packthrid,

thrid, it muſt be no heavier, then being put upon your finger, two or three fingers breadths from the mouthof the ſame, it may juſt ballaſt the Rocket; then it is prepared for uſe.

Chap. 12.

How to give fire to one or more Rockets.

SEt your Rockets mouth upou the edge of any peece of timber, battlement of a wall, top of the Gunners carriage wheele, or any dry place whatſoever, where the rod or twigge may hang perpendicular from it, then lay a train of powder that may come under the mouth thereof, give fire thereunto and you have done. But if you would fire more Rockets then one, that as one deſcendeth the other may aſcend by degrees, make this compoſition following, of *Roch peeter* 8 ounces, *Quick Brimſtone* 4 ounces, and fine Powder duſt 2 ounces, which lay in a line from one rocket to another, they being placed ten inches or a foot one

one from another, give fire to this compoſition, and it will worke your deſire, by cauſing one to mount into the aire when the other is ſpent, but before you place your Rockets, remember to prick them with the bodkin, as I have taught you in the tenth Chapter, at the latter end thereof.

Chap. 13.

Divers and ſundry Compoſitions for Stars.

A Compoſition for Stars of a blew colour mixed with red.

Take of *Powder mealed*, 8
Salt-peeter, 4
Quick Brimſtone. 12
} ounces.

Meale all theſe very fine, and mix them together with two ounces of *Aquavitæ*, and halfe an ounce of oile of *Spike*, which let be very dry before you uſe it.

Ano-

Another Compoſition which maketh a white and beautifull fire.

Take *Powder*,	8	Ounces.
Salt-peeter,	24	
Quick Brimſtone.	12	
Camphire	1	

Meale theſe Ingredients and incorporate them: Now to meale your *Camphire*, take a braſſe peſtle and morter, wet the end of the peſtle in a little of the oyle of Almonds, and it will meale to powder, then keepe it cloſe from the aire, elſe it will become of no uſe.

Another white fire which laſteth long.

Take *Powder*,	4	Ounces.
Salt-peeter,	16	
Brimſtone,	8	
Camphire,	1	
Oile of Peeter.	2	

Meale thoſe that are to be mealed, and mixe them according to the former directions

CHAP.

Chap. 14.

The manner of making Stars; and to use them.

TAke litle four squar pieces of brown paper, which fill with the composition you approve of best, of the three last taught: so double it down, rouling it untill you make it round, about the bigness of a nut, or bigger, according to the size of your Rocket, that you intend them for, prime them, with drawing thorow them Cotton-week, and they are prepared.

You may also make them after this manner, you must have a rouler which must be as big as an ordinary arrow, which shall be to roule a length of paper about it, and with a little glue past it round; when it is dry draw out the rouler, and fill it by little and little, with a thimble: still thrusting it down, every filling of a thimble, with the rouler; which being filled cut it in short pieces, about half an inch long, then having in readi-

ness

neſſe either hot glue, or ſize, mingled with red lead; dip therein one end of your ſhort peeces, leſt they take fire at both ends together; and becauſe that it may not ſo eaſily blow out: theſe being thus finiſhed, ſet them to dry untill you have occaſion to uſe them: and then putting the open end in powder on the top of the Rocket, in that place after the firſt paſtboard, or cover, is placed in a Rocket; next the compoſition, where I taught you before to put powder for to make a report: which now you muſt leave out to place in theſe Stars; after this manner make two or three holes in that paſtboard, which prime with powder-duſt: and thereupon put a little Piſtoll powder, to blow the Stars out, when the Rocket is ſpent: after the powder, put as I have ſaid before, the open ends of theſe Stars, down upon that powder: when you have put them ſo cloſe as they can ſtick one by the other, put a little ſmall corned powder on the top of them, to run between them, and put another tyre of Stars upon that, and in like manner a third tyre upon them, till you come to the top of the Rocket-caſe, there put a paper over the head of it, and tye it cloſe about the top, that

none

none of the powder come from under or between the Stars.

How to prepare the Cotton-week, to prime the first sort of Stars.

Take Cotton-week, such as the Chandlers use for Candles, double it six or seven times double; and wet it thoroughly in *Saltpeeter* water, or *Aquavitæ*, wherein some *Camphire* hath been dissolved; or for want of either in fair water, cut it in divers pieces, roule in mealed powder, dry it in the Sun, and it is done.

Chap. 15.

How to make silver and golden Rain, and how to use them.

NOw I shew you the order of making golden Rain, which is after this manner, you must provide store of Goose-quils, which being provided, you must

muſt cut them off ſo long as they are hollow, the compoſition to fill theſe muſt be made thus; two ounces of cole-duſt to one pound of powder well mixed; having filled many of theſe quils, you ſhall place them in the ſame place as I taught you to put the powder and Stars, firſt putting a ſmall quantity of Piſtol powder under them, to blow them out when the Rocket is ſpent: upon this put your quils, as many as will fill the top of the caſe, with the open end downwards, ſo ſoon as the Rocket is ſpent, you ſhall ſee appeare a golden ſhowre, which by ſome is called golden Rain, the like way you may make ſilver Rain; filling the quils with the Compoſition for white Stars.

CHAP.

Chap. 16.

How to make Fiſgigs, which ſome call by the name of Serpents, and to uſe them.

You muſt provide a ſmal rouling pin, about one quarter of an inch in thicknesſe, upon which roule ſeven or eight thicknesſes of paper: fill them foure inches with powder duſt, ſomtimes putting between the filling a little of the Compoſition for Rockets of 10 ounces: and at the end of foure inches choak him, fill two inches more with Piſtoll powder, then choak the end up: at the other end put in a little of the mixture for Stars, and choake betweene that & the compoſition, & you have done: put divers of theſe with the Starry end downwards, upon the head of a Rocket, as you did the quils, with powder to blow them out, when the Rocket is ſpent, they will firſt appeare like ſo many Stars, when the Stars are ſpent, taking hold of the powder

der duſt; they will run wrigling to and fro like Serpents, and when that Compoſition is ſpent, they will end with every one a report, which will give great content. I ſhall have occaſion to ſpeak of theſe Fiſgigs in other Fire-works.

Chap. 17.

How to make Girondels, or (as ſome call them) Fire Wheels.

A Fire Wheele, is often required in great Works for pleaſure, and therefore I have thought fit and neceſſary, to ſet downe their deſcription: as well as of all other ſorts of Fire-works; Firſt, you muſt make a Wheele of Wood, ſo big as you pleaſe to make Girondels, and unto theſe binde Rockets very faſt of a mean bigneſſe, with the mouth of one towards the tayle of another, thus continuing untill you have filled your Wheele quite round, which done, cover them with paper paſted very curiouſly, that one taking fire, they may not take

take fire altogether; and daube Sope upon them quite round, leaving the mouth of one of them open to give fire thereto, for the firſt Rocket having burned, will give fire to the next; keeping the Wheele in continuall motion, untill they be all ſpent: there may be bound fire Lances, to theſe Girondels, either upright, or neer, overthwart, which will make to appear diverſity of fiery Circles; Your care muſt be, to place the Girondels at a convenient diſtance, from other Fire-Works: leſt they ſhould cauſe confuſion, and ſpoyle all your Work.

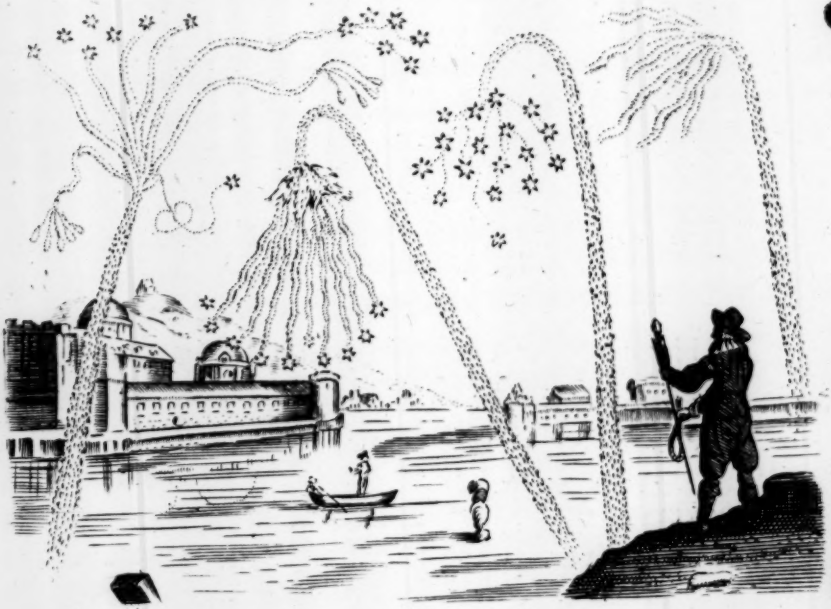
Chap. 18.

How to repreſent divers ſorts of Figures in the Aire with Rockets.

I Have taught you to make a report upon the head of a Rocket, and alſo to place golden or ſilver Haire or Rain, or Stars, or Fiſgigs, which when you have divers Rockets to make for a great Fire-work, let one be with a report, the next with Stars, an-

another with Gold Haire, or Rain, one with Silver Haire or Rain, for ſtanding juſt under the Rocket it appeareth like Rain, but being aſide hand like Golden or Silver Haire: and upon the head of another Rocket place the Fiſgigs, which when the Rocket is ſpent will firſt appear like ſo many Stars after they are ended, they will ſhew like Serpents wrigling to and fro, and laſtly, give every one his report.

To repreſent a Tree in the Ayre.



It is a rare thing to repreſent a Tree or Fountain, in the aire, which made by putting many little Rockets upon one great one, paſſing all the rods of the little ones thorow wires, made on purpoſe upon the ſides of the great one, or ſome other way, as your induſtry will diſcover, now if the little ones take fire while the great one is mounting up, they will repreſent a Tree, but if they take fire as the great one is deſcending or turning down again towards the ground; then they will be like a fountain of fire, if there be two or three little Rockets amongſt others, that have no rods, they will make divers motions contrary to the reſt, very pleaſing.

If before you put the Fiſgigs upon the head of a great Rocket, you with a ſmall ſtring tye them together, a foot of line between, when they are on fire in the Aire you will ſee very great variety of Figures, becauſe as they wriggle to and fro, they will pull one another after them, to the ſpeculatour a great deal of content: it will be pleaſant if you tye them not all together but three or four, which will in the firing of them,

them, be diſtinguiſhed from the reſt, with great variety.

Chah. 19.

How to make Fire-lances.

THe uſe of theſe Lances is much required in all great Fire-Works, and I taught you before to uſe them in the Fire-Wheels, the manner of their making is thus, you muſt make Cartouches or caſes juſt like the caſes for Rockets: onely theſe for a need may be made of paſtboard, and glued as they are a rouling of them, if for great ones; but it is beſt to make little ones of paper, the caſe being provided, let them be filled with the dry compoſition for Stars; in the thirteenth Chapter of this Book: prime them with wet Gunpowder, the lower end of the caſe is ſtopped with a piece of wood, to the end they may be nailed, and ſtuck, when, and where, they ſhall be

be uſed, the wood being about three fingers breadth long, out of the Cartouch.

Chap. 20.

How to make a Rocket, which firing it out of your hand, ſhall continually be in agitation, either on the earth, or in the aire.

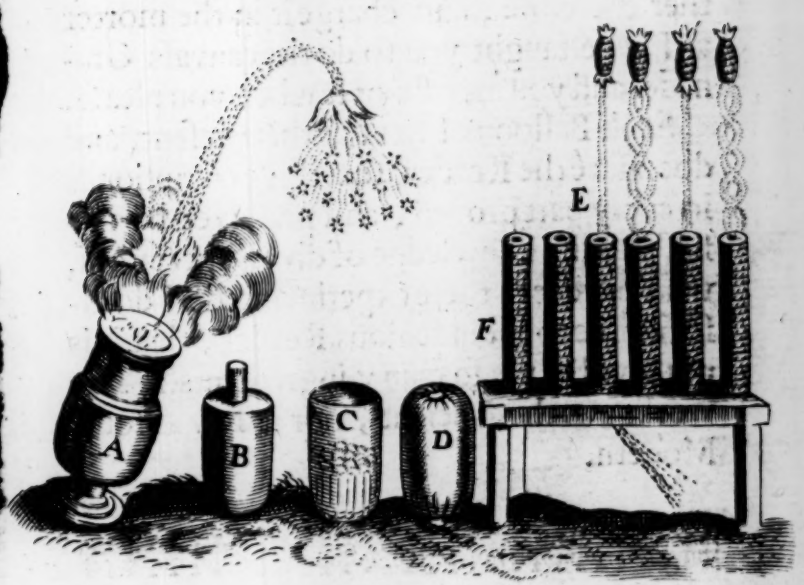
HAving prepared a rocket with a report in the head, ſuch as I taught you firſt to make, tye it to a bladder, ſo that the end of the rocket may come to the mouth of the ſaid bladder, and binde it over very ſtrongly, then firing it out of your hand, caſt it away from you, it matters not which way, ſo it wil come to the ground; there by reaſon of the bladder it cannot ſtay, but preſently rebounds upwards, moving to and fro, untill all be ſpent: there is another ſort, and that is a ſmall rocket, put into bladder, and ſo blown up round about it, and tyed about the neck thereof, which will have delightfull motions.

Chap. 21.

The manner how to make Balloones for the Morter-peece.

First, you muſt provide a wooden rowler, twice ſo long as in diameter, you muſt have it of ſuch bigneſſe as you deſire to make the inſide of your Balloone, upon which rouler let there be rouled ſo many paſtbords as you ſhall thinke ſufficient for ſtrength, being well glued together: then choak this Cartouch at the one end, leaving a little hole for a port-fire, as ſhall follow, and glue it in, this por-tfire ſhall be made juſt like a Rocket, of the bigneſſe of the hole you leave open for it, and filled with compoſition for Rockets of that ſize, not pricking it with a bodkin, as you are taught to prick other Rockets, and to know of what length this port-fire ought to be, it will not be amiſſe to try one Balloon filled with earth, and your port-fire faſtned there-

unto



unto: Now to fill the Balloon place all your Serpents within it, together with Stars, Rockets and Crackers, in such a convenient manner that there may be very little void room, within the Cartouch : it being thus filled, put in as much powder duſt as you can that it may run every where thorow the chinks, between the Serpents, Rockets, and Stars, that they may all fire; and that the ſaid powder duſt may break the Balloon: theſe

things being thus disposed choak up the other end close, and charge it in the morter as I have taught you to do the canvass Granade; and you may shoot it when you please.

Such Balloons I have at this present, and doe assure the Reader, that this description is in every part proved, and practized by my self; to the knowledge of divers spectators, who have seen these experimented, I do also signifie to the ingenious Reader, that it is not good to use so many ingredients (in Fire works) as the Ancient, nor so few as some Modern.

CHAP. 22.

A most pretious Unguent for any burning.

BEcause that divers men in their practising Fire-works, one time or other chance to be burned by them, and also by the blowing up of Gunpowder many are burned in the face, or elswhere. I will shew you such salves which I have cured my self withall, I having them out of Master

ſter *Malthus* his Fire-works, and experimen-ted them upon my ſelfe to my great good when I was burned.

The Unguent.

TAke freſh Hogſ-greaſe or Lard, as much as you pleaſe, and boyle it taking off the skin untill there ariſe no more skin, then ſet the Lard three or four nights abroad, after which it muſt be waſhed in running water, to take away the ſaltiſh nature, and alſo to cleanſe it white, then melt it, and keep it for your uſe.

Otherwiſe.

THe white of an Egge, and freſh butter, being mingled together and well beaten into an ointment, is excellent.

Ano-

Another ſort moſt excellent.

TAke a ſtone of quick Lime, and let it diſſolve in cleer water, and when the water is ſetled, poure it gently out from the Lime, thorow a linnen cloth, then put as much ſallet oile (as you take water) together, and beating it all to an oile, you ſhall have a moſt excellent Unguent for all manner of burning.

FINIS.